TEXTE
74/2019

Test scenarios

for the determination of sound emissions from road, rail, industry and the calculation of the propagation of sound (BUB), the calculation of environmental noise from airports (BUF) and assessment of the noise exposure of affected persons (BEB) according to Directive (EU) 2015/996

For our Environment

Umwelt Bundesamt

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for the determination of sound emissions from road, rail, industry and the calculation of the propagation of sound (BUB), the calculation of environmental noise from airports (BUF) and assessment of the noise exposure of affected persons (BEB) according to Directive (EU) 2015/996

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Index of Abbreviations

The names and abbreviations of the appendices [2] to [6] are used to describe the test cases and are explained there.

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[1] Commission Directive (EU) 2015/996 of 19 May 2015 establishing common noise assessment methods in accordance with Directive 2002/49/EC of the European Parliament and of the Council.

[2] Appendix 1, Environmental noise calculation method for sources close to the ground (roads, railways, industry and commerce) (BUB) 20.11.2018

[3] Appendix 2, Calculation method for environmental noise from airports (BUF), 20.11.2018

[4] Appendix 3, Calculation method for determining the number of persons exposed to environmental noise (BEB), 20.11.2018

[5] Appendix 4, Database for the environmental noise calculation method for ground-level sources (roads, railways, industry and commerce), (BUB-D), 20.11.2018

[6] Appendix 5, Database for the calculation method for the environmental noise of airports, (BUF-D), 20.11.2018

[7] Test cases for the verification of calculation programs for the determination of the noise indices of CNOSSOS-EU - Annex II of the Environmental Noise Directive - for noise emissions from roads TEST-CNOSSOS-EStr (Emission-Road), Version 1.5, German Federal Highway Research Institute (Bundesanstalt für Straßenwesen), 9 July 2018

[8] Test scenarios for the verification of calculation programs for the determination of noise indices according to Section 3 of Annex 1 Calculation method for environmental noise from sources close to the ground (roads, railways, industry and commerce), (BUB), railways, TEST-CNOSSOS-DE-Sch, (emission rail), Version 1.10, German Federal Railway Authority (Eisenbahnbundesamt), 28 September 2018

[9] Test scenarios for sound propagation and industrial emissions for the calculation method for environmental noise from sources close to the ground – BUB, and for the calculation method for determining the number of affected persons by environmental noise - BEB, German Federal Environmental Agency (Umweltbundesamt), 31 October 2018

[10] Development of test scenarios for air traffic related noise scenarios for the quality-assured application of the calculation method for the environmental noise of airports - BUF Description of the test scenarios, Umweltbundesamt (German Federal Environmental Agency), 24 October 2018

[11] DIN 45687 "Acoustics - Software products for outdoor noise immission calculation - Quality requirements and test specifications", May 2006

1 Introduction

To improve the noise situation in Europe, the EU issued the Environmental Noise Directive (2002/49/EC) in 2002. It was transposed into German law in 2005. The aim is to reduce environmental noise and prevent an increase in noise in previously quiet areas. To this end, noise pollution is to be recorded in noise maps by means of uniform assessment methods for noise indices in Europe and then reduced by means of concrete measures. In recent years, the EU has developed these methods under the acronym CNOSSOS-EU (Common Noise Assessment Methods in Europe) with the participation of the Member States. These calculation methods were introduced by an amendment to Annex II of the EU Environmental Noise Directive 2015 as Directive (EU) 2015/996 [1] for subsequent national implementation ([2] to [6]) and are to be applied by all Member States as of 1 January 2019.

In this documentation, the methods for the determination of sound emissions, the calculation of sound propagation and the assessment of noise exposure are applied to exemplary scenarios. A distinction is made between noise from sources close to the ground (road, rail, industry) and sources from air traffic (aircraft noise). In accordance with the calculation regulations [2] to [6], model calculations (creating scenarios and test cases) are documented in detail. This way, a quality assurance of noise calculations in accordance with DIN 45687 [11] is made possible and a uniform and comprehensible application of the methods is ensured throughout Germany.

2 Test scenarios for BUB, noise emission roads

2.1 Purpose

The calculation of noise immissions from road traffic is carried out according to [2] and [5].

The set of test cases documented in this chapter covers noise emissions from motor vehicles on roads; other noise immissions are not covered here.

2.2 Preliminary remarks

All results of the test cases in this chapter are given with an accuracy of three decimal places. Proof of the correctness of the test results is provided by a comparison with the specified result of the test case. A tolerance of not more than "1" in the last decimal place is allowed. For a specified value of 1.000, for example, the calculated result may also be 0.999 or 1.001.

In the test cases, only the numerical values are given, while the units are omitted.

For spectral level specifications, the eight octave bands specified in Regulation 2015/996 with center frequencies from 63 Hz to 8 kHz were applied.

2.3 Test Cases

2.3.1 Rolling noise - Base value

Scenario R0: Rolling noise - Base value

Tables 2.3.1-1 to 2.3.1-8 give the sound power levels of rolling noise $L_{WR,i,m}$ for the frequency bands i for the three vehicle categories m = 1, 2 and 3 as a function of speed v_m . The correction terms $\Delta L_{WR,i,m}$ are set to zero here.

Table 2.3.1-1: R0.1, Base value of rolling noise in frequency band 1 (Source: Bundesanstalt für Straßenwesen [7])

m	v_m	$L_{WR,i,m}$
-	km/h	dB
1	30	68.661
1	50	75.316
1	70	79.700
1	140	88.731
2	30	72.961
2	50	79.616
2	70	84.000
2	90	87.274
3	30	75.961
3	50	82.616
3	70	87.000
3	90	90.274

Table 2.3.1-2: R0.2, Base value of rolling noise in frequency band 2 (Source: Bundesanstalt für Straßenwesen [7])

m	v_m	$L_{WR,i,m}$
-	km/h	dB
1	30	70.429
1	50	79.636
1	70	85.700
1	140	98.193
2	30	75.526
2	50	83.469
2	70	88.700
2	90	92.607
3	30	79.373
3	50	86.805
3	70	91.700
3	90	95.356

Table 2.3.1-3: R0.3, Base value of rolling noise in frequency band 3 (Source: Bundesanstalt für Straßenwesen [7])

m	v_m	$L_{WR,i,m}$
-	km/h	dB
1	30	70.186
1	50	78.816
1	70	84.500
1	140	96.210
2	30	79.504
2	50	86.736
2	70	91.500
2	90	95.058
3	30	82.582
3	50	89.526
3	70	94.100
3	90	97.516

Table 2.3.1-4: R0.4, Base value of rolling noise in frequency band 4 (Source: Bundesanstalt für Straßenwesen [7])

m	v_m	$L_{WR,i,m}$
-	km/h	dB
1	30	80.743
1	50	86.445
1	70	90.200
1	140	97.936
2	30	87.942
2	50	93.222
2	70	96.700
2	90	99.298
3	30	91.353
3	50	96.988
3	70	100.700
3	90	103.472

Table 2.3.1-5: R0.5, Base value of rolling noise in frequency band 5 (Source: Bundesanstalt für Straßenwesen [7])

m	v_m	$L_{WR,i,m}$
-	km/h	dB
1	30	85.341
1	50	92.551
1	70	97.300
1	140	107.083
2	30	86.324
2	50	93.002
2	70	97.400
2	90	100.685
3	30	89.098
3	50	96.153
3	70	100.800
3	90	104.271

Table 2.3.1-6: R0.6, Base value of rolling noise in frequency band 6 (Source: Bundesanstalt für Straßenwesen [7])

m	v_m	$L_{WR,i,m}$
-	km/h	dB
1	30	80.211
1	50	88.464
1	70	93.900
1	140	105.098
2	30	77.579
2	50	85.610
2	70	90.900
2	90	94.851
3	30	80.648
3	50	88.879
3	70	94.300
3	90	98.349

Table 2.3.1-7: R0.7, Base value of rolling noise in frequency band 7 (Source: Bundesanstalt für Straßenwesen [7])

m	v_m	$L_{WR,i,m}$
-	km/h	dB
1	30	69.749
1	50	78.401
1	70	84.100
1	140	95.840
2	30	69.706
2	50	78.203
2	70	83.800
2	90	87.980
3	30	72.896
3	50	81.459
3	70	87.100
3	90	91.313

Table 2.3.1-8: R0.8, Base value of rolling noise in frequency band 8 (Source: Bundesanstalt für Straßenwesen [7])

m	v_m	$L_{WR,i,m}$
-	km/h	dB
1	30	59.581
1	50	68.455
1	70	74.300
1	140	86.341
2	30	65.744
2	50	74.640
2	70	80.500
2	90	84.877
3	30	67.560
3	50	76.567
3	70	82.500
3	90	86.931

A computer program may only assume values from 30 km/h to 140 km/h for the speeds for vehicle class 1 and only values from 30 km/h to 90 km/h in steps of 10 km/h for vehicle classes 2 and 3.

2.3.2 Rolling noise - Road surface

Scenario R1: Rolling noise - Road surface

Tables 2.3.2-1 to 2.3.2-24 give the correction terms of the rolling noise $\Delta L_{WR,road,i,m}$ for the road surface layer types for the three vehicle categories m = 1, 2 and 3 as a function of speed v_m. These results must be obtained for all eight spectral bands i = 1 to 8.

Road surfaces with paving setts or slabs are only considered flat if they are made of components with slightly or moderately textured or finely prepared surfaces and the joint filling is even with the stone edges, or if the sum of joint width b and chamfers f is less than 9 mm (Figure 2.3.2-1). All other Road surfaces with paving setts or slabs such as cobblestones, concrete interlocking paving stones with a chamfered stone edge, as well as coatings and surfaces with no joint filling and joint widths (incl. chamfers) above 9 mm are not covered by "paving with an even surface".

Figure 2.3.2-1: Differentiation between road surfaces with paving setts or slabs (Source: Bundesanstalt für Straßenwesen [7])

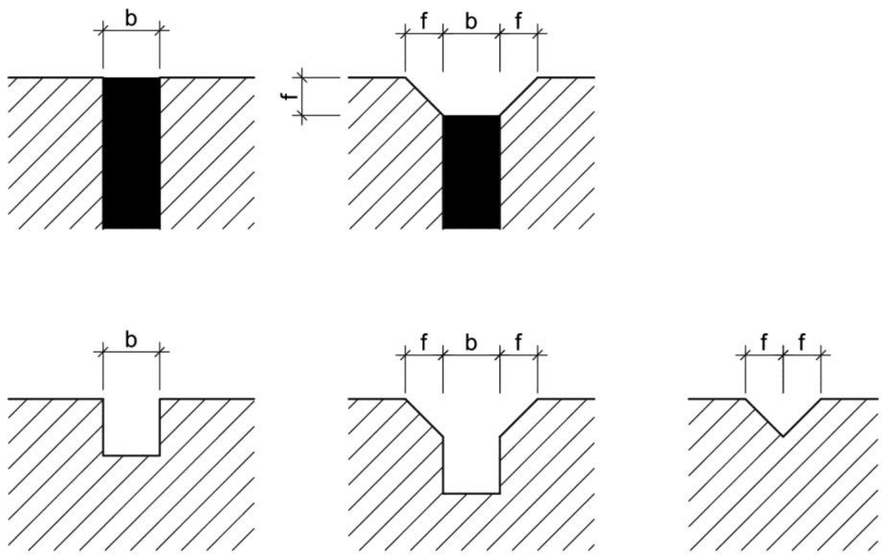


Table 2.3.2-1: R1.1.1, Road surface correction of rolling noise for Class 1 vehicles for frequency band 1 (Source: Bundesanstalt für Straßenwesen [7])

Type of road surface	v_m	$\Delta L_{WR,road,i,m}$
	km/h	dB
Non-corrugated mastic asphalt (national reference)	30	5.298
Non-corrugated mastic asphalt (national reference)	50	4.455
Non-corrugated mastic asphalt (national reference)	70	3.900
Non-corrugated mastic asphalt (national reference)	140	2.756
Stone mastic asphalt SMA 5 and SMA 8 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	30	4.668
Stone mastic asphalt SMA 5 and SMA 8 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	50	4.446
Stone mastic asphalt SMA 8 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	70	3.200
Stone mastic asphalt SMA 8 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	140	2.176
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	30	1.752
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	50	1.419
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	70	1.900
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	140	0.786
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	70	4.300
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	140	3.397
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	70	0.100
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	140	-0.653
Concrete according to ZTV Beton-StB 07 with exposed aggregate concrete surface	70	2.000
Concrete according to ZTV Beton-StB 07 with exposed aggregate concrete surface	140	1.097
Low-noise mastic asphalt according to ZTV Asphalt -StB 07, Method B	70	6.400
Low-noise mastic asphalt according to ZTV Asphalt -StB 07, Method B	140	5.497
Paving setts or slabs with level surface (Figure 2.3.2-1) with b ≤ 5.0 mm and b+2f ≤ 9.0 mm	30	16.218
Paving setts or slabs with level surface (Figure 2.3.2-1) with b ≤ 5.0 mm and b+2f ≤ 9.0 mm	50	17.172
Other paving setts or slabs (Figure 2.3.2-1) with b > 5,0 mm <u>or</u> f > 2.0 mm <u>or</u> cobblestone pavement	30	17.090
Other paving setts or slabs (Figure 2.3.2-1) with b > 5,0 mm <u>or</u> f > 2.0 mm <u>or</u> cobblestone pavement	50	17.579

Table 2.3.2-2: R1.1.2, Road surface correction of rolling noise for Class 1 vehicles for frequency band 2 (Source: Bundesanstalt für Straßenwesen [7])

Type of road surface	v_m	$\Delta L_{WR,road,i,m}$
	km/h	dB
Non-corrugated mastic asphalt (national reference)	30	5.298
Non-corrugated mastic asphalt (national reference)	50	4.455
Non-corrugated mastic asphalt (national reference)	70	3.900
Non-corrugated mastic asphalt (national reference)	140	2.756
Stone mastic asphalt SMA 5 and SMA 8 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	30	2.568
Stone mastic asphalt SMA 5 and SMA 8 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	50	2.346
Stone mastic asphalt SMA 8 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	70	2.900
Stone mastic asphalt SMA 8 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	140	1.876
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	30	1.752
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	50	1.419
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	70	1.900
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	140	0.786
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	70	6.300
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	140	5.397
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	70	2.900
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	140	2.147
Concrete according to ZTV Beton-StB 07 with exposed aggregate concrete surface	70	1.500
Concrete according to ZTV Beton-StB 07 with exposed aggregate concrete surface	140	0.597
Low-noise mastic asphalt according to ZTV Asphalt-StB 07, Method B	70	5.400
Low-noise mastic asphalt according to ZTV Asphalt-StB 07, Method B	140	4.497
Paving setts or slabs with level surface (Figure 2.3.2-1) with $b \leq 5.0$ mm and $b+2f \leq 9.0$ mm	30	14.718
Paving setts or slabs with level surface (Figure 2.3.2-1) with $b \leq 5.0$ mm and $b+2f \leq 9.0$ mm	50	15.672
Other paving setts or slabs (Figure 2.3.2-1) with $b > 5{,}0$ mm <u>or</u> $f > 2.0$ mm <u>or</u> cobblestone pavement	30	16.690
Other paving setts or slabs (Figure 2.3.2-1) with $b > 5{,}0$ mm <u>or</u> $f > 2.0$ mm <u>or</u> cobblestone pavement	50	17.179

Table 2.3.2-3: R1.1.3, Road surface correction of rolling noise for Class 1 vehicles for frequency band 3 (Source: Bundesanstalt für Straßenwesen [7])

Type of road surface	v_m	$\Delta L_{WR,road,i,m}$
	km/h	dB
Non-corrugated mastic asphalt (national reference)	30	5.298
Non-corrugated mastic asphalt (national reference)	50	4.455
Non-corrugated mastic asphalt (national reference)	70	3.900
Non-corrugated mastic asphalt (national reference)	140	2.756
Stone mastic asphalt SMA 5 and SMA 8 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	30	3.768
Stone mastic asphalt SMA 5 and SMA 8 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	50	3.546
Stone mastic asphalt SMA 8 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	70	2.900
Stone mastic asphalt SMA 8 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	140	1.876
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	30	1.752
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	50	1.419
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	70	1.900
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	140	0.786
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	70	4.100
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	140	3.197
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	70	2.000
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	140	1.247
Concrete according to ZTV Beton-StB 07 with exposed aggregate concrete surface	70	2.800
Concrete according to ZTV Beton-StB 07 with exposed aggregate concrete surface	140	1.897
Low-noise mastic asphalt according to ZTV Asphalt-StB 07, Method B	70	4.600
Low-noise mastic asphalt according to ZTV Asphalt-StB 07, Method B	140	3.697
Paving setts or slabs with level surface (Figure 2.3.2-1) with b ≤ 5.0 mm and b+2f ≤ 9.0 mm	30	13.618
Paving setts or slabs with level surface (Figure 2.3.2-1) with b ≤ 5.0 mm and b+2f ≤ 9.0 mm	50	14.572
Other paving setts or slabs (Figure 2.3.2-1) with b > 5,0 mm <u>or</u> f > 2.0 mm <u>or</u> cobblestone pavement	30	14.490
Other paving setts or slabs (Figure 2.3.2-1) with b > 5,0 mm <u>or</u> f > 2.0 mm <u>or</u> cobblestone pavement	50	14.979

Table 2.3.2-4: R1.1.4, Road surface correction of rolling noise for Class 1 vehicles for frequency band 4 (Source: Bundesanstalt für Straßenwesen [7])

Type of road surface	v_m	$\Delta L_{WR,road,i,m}$
	km/h	dB
Non-corrugated mastic asphalt (national reference)	30	5.298
Non-corrugated mastic asphalt (national reference)	50	4.455
Non-corrugated mastic asphalt (national reference)	70	3.900
Non-corrugated mastic asphalt (national reference)	140	2.756
Stone mastic asphalt SMA 5 and SMA 8 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	30	4.868
Stone mastic asphalt SMA 5 and SMA 8 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	50	4.646
Stone mastic asphalt SMA 8 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	70	2.800
Stone mastic asphalt SMA 8 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	140	1.776
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	30	1.752
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	50	1.419
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	70	1.900
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	140	0.786
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	70	0.800
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	140	-0.103
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	70	2.800
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	140	2.047
Concrete according to ZTV Beton-StB 07 with exposed aggregate concrete surface	70	3.200
Concrete according to ZTV Beton-StB 07 with exposed aggregate concrete surface	140	2.297
Low-noise mastic asphalt according to ZTV Asphalt-StB 07, Method B	70	4.000
Low-noise mastic asphalt according to ZTV Asphalt-StB 07, Method B	140	3.097
Paving setts or slabs with level surface (Figure 2.3.2-1) with b ≤ 5.0 mm and b+2f ≤ 9.0 mm	30	11.218
Paving setts or slabs with level surface (Figure 2.3.2-1) with b ≤ 5.0 mm and b+2f ≤ 9.0 mm	50	12.172
Other paving setts or slabs (Figure 2.3.2-1) with b > 5,0 mm <u>or</u> f > 2.0 mm <u>or</u> cobblestone pavement	30	11.890
Other paving setts or slabs (Figure 2.3.2-1) with b > 5,0 mm <u>or</u> f > 2.0 mm <u>or</u> cobblestone pavement	50	12.379

Table 2.3.2-5: R1.1.5, Road surface correction of rolling noise for Class 1 vehicles for frequency band 5 (Source: Bundesanstalt für Straßenwesen [7])

Type of road surface	v_m	$\Delta L_{WR,road,i,m}$
	km/h	dB
Non-corrugated mastic asphalt (national reference)	30	5.298
Non-corrugated mastic asphalt (national reference)	50	4.455
Non-corrugated mastic asphalt (national reference)	70	3.900
Non-corrugated mastic asphalt (national reference)	140	2.756
Stone mastic asphalt SMA 5 and SMA 8 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	30	1.668
Stone mastic asphalt SMA 5 and SMA 8 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	50	1.446
Stone mastic asphalt SMA 8 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	70	2.200
Stone mastic asphalt SMA 8 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	140	1.176
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	30	1.752
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	50	1.419
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	70	1.900
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	140	0.786
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	70	-0.300
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	140	-1.203
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	70	-1.700
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	140	-2.453
Concrete according to ZTV Beton-StB 07 with exposed aggregate concrete surface	70	3.300
Concrete according to ZTV Beton-StB 07 with exposed aggregate concrete surface	140	2.397
Low-noise mastic asphalt according to ZTV Asphalt-StB 07, Method B	70	2.200
Low-noise mastic asphalt according to ZTV Asphalt-StB 07, Method B	140	1.297
Paving setts or slabs with level surface (Figure 2.3.2-1) with b ≤ 5.0 mm and b+2f ≤ 9.0 mm	30	6.518
Paving setts or slabs with level surface (Figure 2.3.2-1) with b ≤ 5.0 mm and b+2f ≤ 9.0 mm	50	7.472
Other paving setts or slabs (Figure 2.3.2-1) with b > 5,0 mm <u>or</u> f > 2.0 mm <u>or</u> cobblestone pavement	30	11.890
Other paving setts or slabs (Figure 2.3.2-1) with b > 5,0 mm <u>or</u> f > 2.0 mm <u>or</u> cobblestone pavement	50	12.379

Table 2.3.2-6: R1.1.6, Road surface correction of rolling noise for Class 1 vehicles for frequency band 6 (Source: Bundesanstalt für Straßenwesen [7])

Type of road surface	v_m	$\Delta L_{WR,road,i,m}$
	km/h	dB
Non-corrugated mastic asphalt (national reference)	30	5.298
Non-corrugated mastic asphalt (national reference)	50	4.455
Non-corrugated mastic asphalt (national reference)	70	3.900
Non-corrugated mastic asphalt (national reference)	140	2.756
Stone mastic asphalt SMA 5 and SMA 8 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	30	0.768
Stone mastic asphalt SMA 5 and SMA 8 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	50	0.546
Stone mastic asphalt SMA 8 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	70	1.600
Stone mastic asphalt SMA 8 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	140	0.576
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	30	1.752
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	50	1.419
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	70	1.900
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	140	0.786
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	70	-2.400
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	140	-3.303
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	70	-3.900
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	140	-4.653
Concrete according to ZTV Beton-StB 07 with exposed aggregate concrete surface	70	0.700
Concrete according to ZTV Beton-StB 07 with exposed aggregate concrete surface	140	-0.203
Low-noise mastic asphalt according to ZTV Asphalt-StB 07, Method B	70	0.400
Low-noise mastic asphalt according to ZTV Asphalt -StB 07, Method B	140	-0.503
Paving setts or slabs with level surface (Figure 2.3.2-1) with b ≤ 5.0 mm and b+2f ≤ 9.0 mm	30	2.418
Paving setts or slabs with level surface (Figure 2.3.2-1) with b ≤ 5.0 mm and b+2f ≤ 9.0 mm	50	3.372
Other paving setts or slabs (Figure 2.3.2-1) with b > 5,0 mm or f > 2.0 mm or cobblestone pavement	30	7.590
Other paving setts or slabs (Figure 2.3.2-1) with b > 5,0 mm or f > 2.0 mm or cobblestone pavement	50	8.079

Table 2.3.2-7: R1.1.7, Road surface correction of rolling noise for Class 1 vehicles for frequency band 7 (Source: Bundesanstalt für Straßenwesen [7])

Type of road surface	v_m	$\Delta L_{WR,road,i,m}$
	km/h	dB
Non-corrugated mastic asphalt (national reference)	30	5.298
Non-corrugated mastic asphalt (national reference)	50	4.455
Non-corrugated mastic asphalt (national reference)	70	3.900
Non-corrugated mastic asphalt (national reference)	140	2.756
Stone mastic asphalt SMA 5 and SMA 8 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	30	1.468
Stone mastic asphalt SMA 5 and SMA 8 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	50	1.246
Stone mastic asphalt SMA 8 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	70	2.100
Stone mastic asphalt SMA 8 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	140	1.076
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	30	1.752
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	50	1.419
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	70	1.900
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	140	0.786
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	70	-0.900
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	140	-1.803
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	70	-3.000
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	140	-3.753
Concrete according to ZTV Beton-StB 07 with exposed aggregate concrete surface	70	0.200
Concrete according to ZTV Beton-StB 07 with exposed aggregate concrete surface	140	-0.703
Low-noise mastic asphalt according to ZTV Asphalt-StB 07, Method B	70	1.800
Low-noise mastic asphalt according to ZTV Asphalt-StB 07, Method B	140	0.897
Paving setts or slabs with level surface (Figure 2.3.2-1) with $b \leq 5.0$ mm and $b+2f \leq 9.0$ mm	30	5.418
Paving setts or slabs with level surface (Figure 2.3.2-1) with $b \leq 5.0$ mm and $b+2f \leq 9.0$ mm	50	6.372
Other paving setts or slabs (Figure 2.3.2-1) with $b > 5.0$ mm <u>or</u> $f > 2.0$ mm <u>or</u> cobblestone pavement	30	9.490
Other paving setts or slabs (Figure 2.3.2-1) with $b > 5.0$ mm <u>or</u> $f > 2.0$ mm <u>or</u> cobblestone pavement	50	9.979

Table 2.3.2-8: R1.1.8, Road surface correction of rolling noise for Class 1 vehicles for frequency band 8 (Source: Bundesanstalt für Straßenwesen [7])

Type of road surface	v_m	$\Delta L_{WR,road,i,m}$
	km/h	dB
Non-corrugated mastic asphalt (national reference)	30	5.298
Non-corrugated mastic asphalt (national reference)	50	4.455
Non-corrugated mastic asphalt (national reference)	70	3.900
Non-corrugated mastic asphalt (national reference)	140	2.756
Stone mastic asphalt SMA 5 and SMA 8 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	30	2.168
Stone mastic asphalt SMA 5 and SMA 8 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	50	1.946
Stone mastic asphalt SMA 8 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	70	2.100
Stone mastic asphalt SMA 8 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	140	1.076
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	30	1.752
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	50	1.419
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	70	1.900
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	140	0.786
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	70	1.900
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	140	0.997
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	70	0.100
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	140	-0.653
Concrete according to ZTV Beton-StB 07 with exposed aggregate concrete surface	70	0.400
Concrete according to ZTV Beton-StB 07 with exposed aggregate concrete surface	140	-0.503
Low-noise mastic asphalt according to ZTV Asphalt-StB 07, Method B	70	3.800
Low-noise mastic asphalt according to ZTV Asphalt-StB 07, Method B	140	2.897
Paving setts or slabs with level surface (Figure 2.3.2-1) with b ≤ 5.0 mm and b+2f ≤ 9.0 mm	30	8.318
Paving setts or slabs with level surface (Figure 2.3.2-1) with b ≤ 5.0 mm and b+2f ≤ 9.0 mm	50	9.272
Other paving setts or slabs (Figure 2.3.2-1) with b > 5.0 mm <u>or</u> f > 2.0 mm <u>or</u> cobblestone pavement	30	9.290
Other paving setts or slabs (Figure 2.3.2-1) with b > 5.0 mm <u>or</u> f > 2.0 mm <u>or</u> cobblestone pavement	50	9.779

Table 2.3.2-9: R1.2.1, Road surface correction of rolling noise for Class 2 vehicles for frequency band 1 (Source: Bundesanstalt für Straßenwesen [7])

Type of road surface	v_m	$\Delta L_{WR,road,i,m}$
	km/h	dB
Non-corrugated mastic asphalt (national reference)	30	7.540
Non-corrugated mastic asphalt (national reference)	50	9.204
Non-corrugated mastic asphalt (national reference)	70	10.300
Non-corrugated mastic asphalt (national reference)	90	11.119
Stone mastic asphalt SMA 5 and SMA 8 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	30	3.284
Stone mastic asphalt SMA 5 and SMA 8 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	50	5.946
Stone mastic asphalt SMA 8 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	70	7.900
Stone mastic asphalt SMA 8 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	90	9.537
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	30	2.916
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	50	5.800
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	70	7.800
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	90	9.273
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	70	10.800
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	90	12.841
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	70	7.200
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	90	9.732
Concrete according to ZTV Beton-StB 07 with exposed aggregate concrete surface	70	8.800
Concrete according to ZTV Beton-StB 07 with exposed aggregate concrete surface	90	10.481
Low-noise mastic asphalt according to ZTV Asphalt-StB 07, Method B	70	11.400
Low-noise mastic asphalt according to ZTV Asphalt-StB 07, Method B	90	13.037
Paving setts or slabs with level surface (Figure 2.3.2-1) with b ≤ 5.0 mm and b+2f ≤ 9.0 mm	30	11.736
Paving setts or slabs with level surface (Figure 2.3.2-1) with b ≤ 5.0 mm and b+2f ≤ 9.0 mm	50	11.292
Other paving setts or slabs (Figure 2.3.2-1) with b > 5.0 mm or f > 2.0 mm or cobblestone pavement	30	23.325
Other paving setts or slabs (Figure 2.3.2-1) with b > 5.0 mm or f > 2.0 mm or cobblestone pavement	50	22.526

Table 2.3.2-10: R1.2.2, Road surface correction of rolling noise for Class 2 vehicles for frequency band 2 (Source: Bundesanstalt für Straßenwesen [7])

Type of road surface	v_m	$\Delta L_{WR,road,i,m}$
	km/h	dB
Non-corrugated mastic asphalt (national reference)	30	7.540
Non-corrugated mastic asphalt (national reference)	50	9.204
Non-corrugated mastic asphalt (national reference)	70	10.300
Non-corrugated mastic asphalt (national reference)	90	11.119
Stone mastic asphalt SMA 5 and SMA 8 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	30	3.284
Stone mastic asphalt SMA 5 and SMA 8 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	50	5.946
Stone mastic asphalt SMA 8 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	70	7.900
Stone mastic asphalt SMA 8 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	90	9.537
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	30	2.916
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	50	5.800
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	70	7.800
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	90	9.273
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	70	10.600
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	90	12.641
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	70	7.700
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	90	10.232
Concrete according to ZTV Beton-StB 07 with exposed aggregate concrete surface	70	10.100
Concrete according to ZTV Beton-StB 07 with exposed aggregate concrete surface	90	11.781
Low-noise mastic asphalt according to ZTV Asphalt-StB 07, Method B	70	11.100
Low-noise mastic asphalt according to ZTV Asphalt-StB 07, Method B	90	12.737
Paving setts or slabs with level surface (Figure 2.3.2-1) with b ≤ 5.0 mm and b+2f ≤ 9.0 mm	30	12.236
Paving setts or slabs with level surface (Figure 2.3.2-1) with b ≤ 5.0 mm and b+2f ≤ 9.0 mm	50	11.792
Other paving setts or slabs (Figure 2.3.2-1) with b > 5.0 mm or f > 2.0 mm or cobblestone pavement	30	22.925
Other paving setts or slabs (Figure 2.3.2-1) with b > 5.0 mm or f > 2.0 mm or cobblestone pavement	50	22.126

Table 2.3.2-11: R1.2.3, Road surface correction of rolling noise for Class 2 vehicles for frequency band 3 (Source: Bundesanstalt für Straßenwesen [7])

Type of road surface	v_m	$\Delta L_{WR,road,i,m}$
	km/h	dB
Non-corrugated mastic asphalt (national reference)	30	7.540
Non-corrugated mastic asphalt (national reference)	50	9.204
Non-corrugated mastic asphalt (national reference)	70	10.300
Non-corrugated mastic asphalt (national reference)	90	11.119
Stone mastic asphalt SMA 5 and SMA 8 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	30	3.284
Stone mastic asphalt SMA 5 and SMA 8 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	50	5.946
Stone mastic asphalt SMA 8 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	70	7.900
Stone mastic asphalt SMA 8 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	90	9.537
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	30	2.916
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	50	5.800
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	70	7.800
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	90	9.273
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	70	9.700
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	90	11.741
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	70	8.100
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	90	10.632
Concrete according to ZTV Beton-StB 07 with exposed aggregate concrete surface	70	7.400
Concrete according to ZTV Beton-StB 07 with exposed aggregate concrete surface	90	9.081
Low-noise mastic asphalt according to ZTV Asphalt-StB 07, Method B	70	10.700
Low-noise mastic asphalt according to ZTV Asphalt-StB 07, Method B	90	12.337
Paving setts or slabs with level surface (Figure 2.3.2-1) with b ≤ 5.0 mm and b+2f ≤ 9.0 mm	30	12.236
Paving setts or slabs with level surface (Figure 2.3.2-1) with b ≤ 5.0 mm and b+2f ≤ 9.0 mm	50	11.792
Other paving setts or slabs (Figure 2.3.2-1) with b > 5.0 mm or f > 2.0 mm or cobblestone pavement	30	20.725
Other paving setts or slabs (Figure 2.3.2-1) with b > 5.0 mm or f > 2.0 mm or cobblestone pavement	50	19.926

Table 2.3.2-12: R1.2.4, Road surface correction of rolling noise for Class 2 vehicles for frequency band 4 (Source: Bundesanstalt für Straßenwesen [7])

Type of road surface	v_m	$\Delta L_{WR,road,i,m}$
	km/h	dB
Non-corrugated mastic asphalt (national reference)	30	7.540
Non-corrugated mastic asphalt (national reference)	50	9.204
Non-corrugated mastic asphalt (national reference)	70	10.300
Non-corrugated mastic asphalt (national reference)	90	11.119
Stone mastic asphalt SMA 5 and SMA 8 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	30	3.284
Stone mastic asphalt SMA 5 and SMA 8 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	50	5.946
Stone mastic asphalt SMA 8 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	70	7.900
Stone mastic asphalt SMA 8 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	90	9.537
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	30	2.916
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	50	5.800
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	70	7.800
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	90	9.273
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	70	5.000
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	90	7.041
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	70	5.900
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	90	8.432
Concrete according to ZTV Beton-StB 07 with exposed aggregate concrete surface	70	7.900
Concrete according to ZTV Beton-StB 07 with exposed aggregate concrete surface	90	9.581
Low-noise mastic asphalt according to ZTV Asphalt-StB 07, Method B	70	9.400
Low-noise mastic asphalt according to ZTV Asphalt-StB 07, Method B	90	11.037
Paving setts or slabs with level surface (Figure 2.3.2-1) with b ≤ 5.0 mm and b+2f ≤ 9.0 mm	30	12.636
Paving setts or slabs with level surface (Figure 2.3.2-1) with b ≤ 5.0 mm and b+2f ≤ 9.0 mm	50	12.192
Other paving setts or slabs (Figure 2.3.2-1) with b > 5.0 mm or f > 2.0 mm or cobblestone pavement	30	18.125
Other paving setts or slabs (Figure 2.3.2-1) with b > 5.0 mm or f > 2.0 mm or cobblestone pavement	50	17.326

Table 2.3.2-13: R1.2.5, Road surface correction of rolling noise for Class 2 vehicles for frequency band 5 (Source: Bundesanstalt für Straßenwesen [7])

Type of road surface	v_m	$\Delta L_{WR,road,i,m}$
	km/h	dB
Non-corrugated mastic asphalt (national reference)	30	7.540
Non-corrugated mastic asphalt (national reference)	50	9.204
Non-corrugated mastic asphalt (national reference)	70	10.300
Non-corrugated mastic asphalt (national reference)	90	11.119
Stone mastic asphalt SMA 5 and SMA 8 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	30	3.284
Stone mastic asphalt SMA 5 and SMA 8 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	50	5.946
Stone mastic asphalt SMA 8 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	70	7.900
Stone mastic asphalt SMA 8 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	90	9.537
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	30	2.916
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	50	5.800
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	70	7.800
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	90	9.273
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	70	4.100
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	90	6.141
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	70	1.100
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	90	3.632
Concrete according to ZTV Beton-StB 07 with exposed aggregate concrete surface	70	7.500
Concrete according to ZTV Beton-StB 07 with exposed aggregate concrete surface	90	9.181
Low-noise mastic asphalt according to ZTV Asphalt-StB 07, Method B	70	8.000
Low-noise mastic asphalt according to ZTV Asphalt-StB 07, Method B	90	9.637
Paving setts or slabs with level surface (Figure 2.3.2-1) with b ≤ 5.0 mm and b+2f ≤ 9.0 mm	30	13.336
Paving setts or slabs with level surface (Figure 2.3.2-1) with b ≤ 5.0 mm and b+2f ≤ 9.0 mm	50	12.892
Other paving setts or slabs (Figure 2.3.2-1) with b > 5.0 mm or f > 2.0 mm or cobblestone pavement	30	18.125
Other paving setts or slabs (Figure 2.3.2-1) with b > 5.0 mm or f > 2.0 mm or cobblestone pavement	50	17.326

Table 2.3.2-14: R1.2.6, Road surface correction of rolling noise for Class 2 vehicles for frequency band 6 (Source: Bundesanstalt für Straßenwesen [7])

Type of road surface	v_m	$\Delta L_{WR,road,i,m}$
	km/h	dB
Non-corrugated mastic asphalt (national reference)	30	7.540
Non-corrugated mastic asphalt (national reference)	50	9.204
Non-corrugated mastic asphalt (national reference)	70	10.300
Non-corrugated mastic asphalt (national reference)	90	11.119
Stone mastic asphalt SMA 5 and SMA 8 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	30	3.284
Stone mastic asphalt SMA 5 and SMA 8 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	50	5.946
Stone mastic asphalt SMA 8 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	70	7.900
Stone mastic asphalt SMA 8 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	90	9.537
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	30	2.916
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	50	5.800
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	70	7.800
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	90	9.273
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	70	4.100
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	90	6.141
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	70	1.700
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	90	4.232
Concrete according to ZTV Beton-StB 07 with exposed aggregate concrete surface	70	6.700
Concrete according to ZTV Beton-StB 07 with exposed aggregate concrete surface	90	8.381
Low-noise mastic asphalt according to ZTV Asphalt-StB 07, Method B	70	7.700
Low-noise mastic asphalt according to ZTV Asphalt-StB 07, Method B	90	9.337
Paving setts or slabs with level surface (Figure 2.3.2-1) with b ≤ 5.0 mm and b+2f ≤ 9.0 mm	30	12.736
Paving setts or slabs with level surface (Figure 2.3.2-1) with b ≤ 5.0 mm and b+2f ≤ 9.0 mm	50	12.292
Other paving setts or slabs (Figure 2.3.2-1) with b > 5.0 mm or f > 2.0 mm or cobblestone pavement	30	13.825
Other paving setts or slabs (Figure 2.3.2-1) with b > 5.0 mm or f > 2.0 mm or cobblestone pavement	50	13.026

Table 2.3.2-15: R1.2.7, Road surface correction of rolling noise for Class 2 vehicles for frequency band 7 (Source: Bundesanstalt für Straßenwesen [7])

Type of road surface	v_m	$\Delta L_{WR,road,i,m}$
	km/h	dB
Non-corrugated mastic asphalt (national reference)	30	7.540
Non-corrugated mastic asphalt (national reference)	50	9.204
Non-corrugated mastic asphalt (national reference)	70	10.300
Non-corrugated mastic asphalt (national reference)	90	11.119
Stone mastic asphalt SMA 5 and SMA 8 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	30	3.284
Stone mastic asphalt SMA 5 and SMA 8 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	50	5.946
Stone mastic asphalt SMA 8 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	70	7.900
Stone mastic asphalt SMA 8 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	90	9.537
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	30	2.916
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	50	5.800
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	70	7.800
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	90	9.273
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	70	5.700
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	90	7.741
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	70	3.300
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	90	5.832
Concrete according to ZTV Beton-StB 07 with exposed aggregate concrete surface	70	7.400
Concrete according to ZTV Beton-StB 07 with exposed aggregate concrete surface	90	9.081
Low-noise mastic asphalt according to ZTV Asphalt-StB 07, Method B	70	9.100
Low-noise mastic asphalt according to ZTV Asphalt-StB 07, Method B	90	10.737
Paving setts or slabs with level surface (Figure 2.3.2-1) with b ≤ 5.0 mm and b+2f ≤ 9.0 mm	30	12.636
Paving setts or slabs with level surface (Figure 2.3.2-1) with b ≤ 5.0 mm and b+2f ≤ 9.0 mm	50	12.192
Other paving setts or slabs (Figure 2.3.2-1) with b > 5.0 mm <u>or</u> f > 2.0 mm <u>or</u> cobblestone pavement	30	15.725
Other paving setts or slabs (Figure 2.3.2-1) with b > 5.0 mm <u>or</u> f > 2.0 mm <u>or</u> cobblestone pavement	50	14.926

Table 2.3.2-16: R1.2.8, Road surface correction of rolling noise for Class 2 vehicles for frequency band 8 (Source: Bundesanstalt für Straßenwesen [7])

Type of road surface	v_m	$\Delta L_{WR,road,i,m}$
	km/h	dB
Non-corrugated mastic asphalt (national reference)	30	7.540
Non-corrugated mastic asphalt (national reference)	50	9.204
Non-corrugated mastic asphalt (national reference)	70	10.300
Non-corrugated mastic asphalt (national reference)	90	11.119
Stone mastic asphalt SMA 5 and SMA 8 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	30	3.284
Stone mastic asphalt SMA 5 and SMA 8 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	50	5.946
Stone mastic asphalt SMA 8 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	70	7.900
Stone mastic asphalt SMA 8 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	90	9.537
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	30	2.916
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	50	5.800
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	70	7.800
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	90	9.273
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	70	6.700
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	90	8.741
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	70	4.900
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	90	7.432
Concrete according to ZTV Beton-StB 07 with exposed aggregate concrete surface	70	7.400
Concrete according to ZTV Beton-StB 07 with exposed aggregate concrete surface	90	9.081
Low-noise mastic asphalt according to ZTV Asphalt-StB 07, Method B	70	9.600
Low-noise mastic asphalt according to ZTV Asphalt-StB 07, Method B	90	11.237
Paving setts or slabs with level surface (Figure 2.3.2-1) with $b \leq 5.0$ mm and $b+2f \leq 9.0$ mm	30	11.736
Paving setts or slabs with level surface (Figure 2.3.2-1) with $b \leq 5.0$ mm and $b+2f \leq 9.0$ mm	50	11.292
Other paving setts or slabs (Figure 2.3.2-1) with $b > 5.0$ mm or $f > 2.0$ mm or cobblestone pavement	30	15.525
Other paving setts or slabs (Figure 2.3.2-1) with $b > 5.0$ mm or $f > 2.0$ mm or cobblestone pavement	50	14.726

Table 2.3.2-17: R1.3.1, Road surface correction of rolling noise for Class 3 vehicles for frequency band 1 (Source: Bundesanstalt für Straßenwesen [7])

Type of road surface	v_m	$\Delta L_{WR,road,i,m}$
	km/h	dB
Non-corrugated mastic asphalt (national reference)	30	9.126
Non-corrugated mastic asphalt (national reference)	50	9.171
Non-corrugated mastic asphalt (national reference)	70	9.200
Non-corrugated mastic asphalt (national reference)	90	9.222
Stone mastic asphalt SMA 5 and SMA 8 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	30	10.480
Stone mastic asphalt SMA 5 and SMA 8 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	50	8.261
Stone mastic asphalt SMA 8 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	70	6.500
Stone mastic asphalt SMA 8 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	90	8.355
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	30	6.240
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	50	5.131
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	70	6.400
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	90	8.255
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	70	9.500
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	90	11.868
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	70	5.700
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	90	8.614
Concrete according to ZTV Beton-StB 07 with exposed aggregate concrete surface	70	7.400
Concrete according to ZTV Beton-StB 07 with exposed aggregate concrete surface	90	9.408
Low-noise mastic asphalt according to ZTV Asphalt-StB 07, Method B	70	10.000
Low-noise mastic asphalt according to ZTV Asphalt-StB 07, Method B	90	11.910
Paving setts or slabs with level surface (Figure 2.3.2-1) with b ≤ 5.0 mm and b+2f ≤ 9.0 mm	30	13.389
Paving setts or slabs with level surface (Figure 2.3.2-1) with b ≤ 5.0 mm and b+2f ≤ 9.0 mm	50	10.683
Other paving setts or slabs (Figure 2.3.2-1) with b > 5.0 mm <u>or</u> f > 2.0 mm <u>or</u> cobblestone pavement	30	24.637
Other paving setts or slabs (Figure 2.3.2-1) with b > 5.0 mm <u>or</u> f > 2.0 mm <u>or</u> cobblestone pavement	50	21.841

Table 2.3.2-18: R1.3.2, Road surface correction of rolling noise for Class 3 vehicles for frequency band 2 (Source: Bundesanstalt für Straßenwesen [7])

Type of road surface	v_m	$\Delta L_{WR,road,i,m}$
	km/h	dB
Non-corrugated mastic asphalt (national reference)	30	9.126
Non-corrugated mastic asphalt (national reference)	50	9.171
Non-corrugated mastic asphalt (national reference)	70	9.200
Non-corrugated mastic asphalt (national reference)	90	9.222
Stone mastic asphalt SMA 5 and SMA 8 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	30	10.480
Stone mastic asphalt SMA 5 and SMA 8 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	50	8.261
Stone mastic asphalt SMA 8 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	70	6.500
Stone mastic asphalt SMA 8 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	90	8.355
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	30	6.240
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	50	5.131
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	70	6.400
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	90	8.255
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	70	9.300
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	90	11.668
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	70	6.200
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	90	9.114
Concrete according to ZTV Beton-StB 07 with exposed aggregate concrete surface	70	8.700
Concrete according to ZTV Beton-StB 07 with exposed aggregate concrete surface	90	10.708
Low-noise mastic asphalt according to ZTV Asphalt-StB 07, Method B	70	9.700
Low-noise mastic asphalt according to ZTV Asphalt-StB 07, Method B	90	11.610
Paving setts or slabs with level surface (Figure 2.3.2-1) with b ≤ 5.0 mm and b+2f ≤ 9.0 mm	30	13.889
Paving setts or slabs with level surface (Figure 2.3.2-1) with b ≤ 5.0 mm and b+2f ≤ 9.0 mm	50	11.183
Other paving setts or slabs (Figure 2.3.2-1) with b > 5.0 mm or f > 2.0 mm or cobblestone pavement	30	24.237
Other paving setts or slabs (Figure 2.3.2-1) with b > 5.0 mm or f > 2.0 mm or cobblestone pavement	50	21.441

Table 2.3.2-19: R1.3.3, Road surface correction of rolling noise for Class 3 vehicles for frequency band 3 (Source: Bundesanstalt für Straßenwesen [7])

Type of road surface	v_m	$\Delta L_{WR,road,i,m}$
	km/h	dB
Non-corrugated mastic asphalt (national reference)	30	9.126
Non-corrugated mastic asphalt (national reference)	50	9.171
Non-corrugated mastic asphalt (national reference)	70	9.200
Non-corrugated mastic asphalt (national reference)	90	9.222
Stone mastic asphalt SMA 5 and SMA 8 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	30	10.480
Stone mastic asphalt SMA 5 and SMA 8 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	50	8.261
Stone mastic asphalt SMA 8 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	70	6.500
Stone mastic asphalt SMA 8 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	90	8.355
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	30	6.240
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	50	5.131
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	70	6.400
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	90	8.255
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	70	8.400
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	90	10.768
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	70	6.600
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	90	9.514
Concrete according to ZTV Beton-StB 07 with exposed aggregate concrete surface	70	6.000
Concrete according to ZTV Beton-StB 07 with exposed aggregate concrete surface	90	8.008
Low-noise mastic asphalt according to ZTV Asphalt-StB 07, Method B	70	9.300
Low-noise mastic asphalt according to ZTV Asphalt-StB 07, Method B	90	11.210
Paving setts or slabs with level surface (Figure 2.3.2-1) with b ≤ 5.0 mm and b+2f ≤ 9.0 mm	30	13.889
Paving setts or slabs with level surface (Figure 2.3.2-1) with b ≤ 5.0 mm and b+2f ≤ 9.0 mm	50	11.183
Other paving setts or slabs (Figure 2.3.2-1) with b > 5.0 mm <u>or</u> f > 2.0 mm <u>or</u> cobblestone pavement	30	22.037
Other paving setts or slabs (Figure 2.3.2-1) with b > 5.0 mm <u>or</u> f > 2.0 mm <u>or</u> cobblestone pavement	50	19.241

Table 2.3.2-20: R1.3.4, Road surface correction of rolling noise for Class 3 vehicles for frequency band 4 (Source: Bundesanstalt für Straßenwesen [7])

Type of road surface	v_m	$\Delta L_{WR,road,i,m}$
	km/h	dB
Non-corrugated mastic asphalt (national reference)	30	9.126
Non-corrugated mastic asphalt (national reference)	50	9.171
Non-corrugated mastic asphalt (national reference)	70	9.200
Non-corrugated mastic asphalt (national reference)	90	9.222
Stone mastic asphalt SMA 5 and SMA 8 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	30	10.480
Stone mastic asphalt SMA 5 and SMA 8 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	50	8.261
Stone mastic asphalt SMA 8 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	70	6.500
Stone mastic asphalt SMA 8 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	90	8.355
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	30	6.240
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	50	5.131
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	70	6.400
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	90	8.255
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	70	3.700
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	90	6.068
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	70	4.400
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	90	7.314
Concrete according to ZTV Beton-StB 07 with exposed aggregate concrete surface	70	6.500
Concrete according to ZTV Beton-StB 07 with exposed aggregate concrete surface	90	8.508
Low-noise mastic asphalt according to ZTV Asphalt-StB 07, Method B	70	8.000
Low-noise mastic asphalt according to ZTV Asphalt-StB 07, Method B	90	9.910
Paving setts or slabs with level surface (Figure 2.3.2-1) with b ≤ 5.0 mm and b+2f ≤ 9.0 mm	30	14.289
Paving setts or slabs with level surface (Figure 2.3.2-1) with b ≤ 5.0 mm and b+2f ≤ 9.0 mm	50	11.583
Other paving setts or slabs (Figure 2.3.2-1) with b > 5.0 mm <u>or</u> f > 2.0 mm <u>or</u> cobblestone pavement	30	19.437
Other paving setts or slabs (Figure 2.3.2-1) with b > 5.0 mm <u>or</u> f > 2.0 mm <u>or</u> cobblestone pavement	50	16.641

Table 2.3.2-21: R1.3.5, Road surface correction of rolling noise for Class 3 vehicles for frequency band 5 (Source: Bundesanstalt für Straßenwesen [7])

Type of road surface	v_m	$\Delta L_{WR,road,i,m}$
	km/h	dB
Non-corrugated mastic asphalt (national reference)	30	9.126
Non-corrugated mastic asphalt (national reference)	50	9.171
Non-corrugated mastic asphalt (national reference)	70	9.200
Non-corrugated mastic asphalt (national reference)	90	9.222
Stone mastic asphalt SMA 5 and SMA 8 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	30	10.480
Stone mastic asphalt SMA 5 and SMA 8 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	50	8.261
Stone mastic asphalt SMA 8 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	70	6.500
Stone mastic asphalt SMA 8 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	90	8.355
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	30	6.240
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	50	5.131
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	70	6.400
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	90	8.255
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	70	2.800
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	90	5.168
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	70	-0.400
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	90	2.514
Concrete according to ZTV Beton-StB 07 with exposed aggregate concrete surface	70	6.100
Concrete according to ZTV Beton-StB 07 with exposed aggregate concrete surface	90	8.108
Low-noise mastic asphalt according to ZTV Asphalt-StB 07, Method B	70	6.600
Low-noise mastic asphalt according to ZTV Asphalt-StB 07, Method B	90	8.510
Paving setts or slabs with level surface (Figure 2.3.2-1) with b ≤ 5.0 mm and b+2f ≤ 9.0 mm	30	14.989
Paving setts or slabs with level surface (Figure 2.3.2-1) with b ≤ 5.0 mm and b+2f ≤ 9.0 mm	50	12.283
Other paving setts or slabs (Figure 2.3.2-1) with b > 5.0 mm <u>or</u> f > 2.0 mm <u>or</u> cobblestone pavement	30	19.437
Other paving setts or slabs (Figure 2.3.2-1) with b > 5.0 mm <u>or</u> f > 2.0 mm <u>or</u> cobblestone pavement	50	16.641

Table 2.3.2-22: R1.3.6, Road surface correction of rolling noise for Class 3 vehicles for frequency band 6 (Source: Bundesanstalt für Straßenwesen [7])

Type of road surface	v_m	$\Delta L_{WR,road,i,m}$
	km/h	dB
Non-corrugated mastic asphalt (national reference)	30	9.126
Non-corrugated mastic asphalt (national reference)	50	9.171
Non-corrugated mastic asphalt (national reference)	70	9.200
Non-corrugated mastic asphalt (national reference)	90	9.222
Stone mastic asphalt SMA 5 and SMA 8 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	30	10.480
Stone mastic asphalt SMA 5 and SMA 8 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	50	8.261
Stone mastic asphalt SMA 8 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	70	6.500
Stone mastic asphalt SMA 8 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	90	8.355
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	30	6.240
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	50	5.131
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	70	6.400
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	90	8.255
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	70	2.800
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	90	5.168
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	70	0.200
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	90	3.114
Concrete according to ZTV Beton-StB 07 with exposed aggregate concrete surface	70	5.300
Concrete according to ZTV Beton-StB 07 with exposed aggregate concrete surface	90	7.308
Low-noise mastic asphalt according to ZTV Asphalt-StB 07, Method B	70	6.300
Low-noise mastic asphalt according to ZTV Asphalt-StB 07, Method B	90	8.210
Paving setts or slabs with level surface (Figure 2.3.2-1) with b ≤ 5.0 mm and b+2f ≤ 9.0 mm	30	14.389
Paving setts or slabs with level surface (Figure 2.3.2-1) with b ≤ 5.0 mm and b+2f ≤ 9.0 mm	50	11.683
Other paving setts or slabs (Figure 2.3.2-1) with b > 5.0 mm <u>or</u> f > 2.0 mm <u>or</u> cobblestone pavement	30	15.137
Other paving setts or slabs (Figure 2.3.2-1) with b > 5.0 mm <u>or</u> f > 2.0 mm <u>or</u> cobblestone pavement	50	12.341

Table 2.3.2-23: R1.3.7, Road surface correction of rolling noise for Class 3 vehicles for frequency band 7 (Source: Bundesanstalt für Straßenwesen [7])

Type of road surface	v_m	$\Delta L_{WR,road,i,m}$
	km/h	dB
Non-corrugated mastic asphalt (national reference)	30	9.126
Non-corrugated mastic asphalt (national reference)	50	9.171
Non-corrugated mastic asphalt (national reference)	70	9.200
Non-corrugated mastic asphalt (national reference)	90	9.222
Stone mastic asphalt SMA 5 and SMA 8 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	30	10.480
Stone mastic asphalt SMA 5 and SMA 8 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	50	8.261
Stone mastic asphalt SMA 8 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	70	6.500
Stone mastic asphalt SMA 8 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	90	8.355
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	30	6.240
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	50	5.131
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	70	6.400
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	90	8.255
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	70	4.400
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	90	6.768
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	70	1.800
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	90	4.714
Concrete according to ZTV Beton-StB 07 with exposed aggregate concrete surface	70	6.000
Concrete according to ZTV Beton-StB 07 with exposed aggregate concrete surface	90	8.008
Low-noise mastic asphalt according to ZTV Asphalt-StB 07, Method B	70	7.700
Low-noise mastic asphalt according to ZTV Asphalt-StB 07, Method B	90	9.610
Paving setts or slabs with level surface (Figure 2.3.2-1) with $b \leq 5.0$ mm and $b+2f \leq 9.0$ mm	30	14.289
Paving setts or slabs with level surface (Figure 2.3.2-1) with $b \leq 5.0$ mm and $b+2f \leq 9.0$ mm	50	11.583
Other paving setts or slabs (Figure 2.3.2-1) with $b > 5.0$ mm <u>or</u> $f > 2.0$ mm <u>or</u> cobblestone pavement	30	17.037
Other paving setts or slabs (Figure 2.3.2-1) with $b > 5.0$ mm <u>or</u> $f > 2.0$ mm <u>or</u> cobblestone pavement	50	14.241

Table 2.3.2-24: R1.3.8, Road surface correction of rolling noise for Class 3 vehicles for frequency band 8 (Source: Bundesanstalt für Straßenwesen [7])

Type of road surface	v_m	$\Delta L_{WR,road,i,m}$
	km/h	dB
Non-corrugated mastic asphalt (national reference)	30	9.126
Non-corrugated mastic asphalt (national reference)	50	9.171
Non-corrugated mastic asphalt (national reference)	70	9.200
Non-corrugated mastic asphalt (national reference)	90	9.222
Stone mastic asphalt SMA 5 and SMA 8 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	30	10.480
Stone mastic asphalt SMA 5 and SMA 8 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	50	8.261
Stone mastic asphalt SMA 8 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	70	6.500
Stone mastic asphalt SMA 8 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	90	8.355
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	30	6.240
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	50	5.131
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	70	6.400
Stone mastic asphalt SMA 5 and SMA 11 in accordance with ZTV Asphalt-StB 07 and spreading with a material of delivery particle size 1/3	90	8.255
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	70	5.400
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	90	7.768
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	70	3.400
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	90	6.314
Concrete according to ZTV Beton-StB 07 with exposed aggregate concrete surface	70	6.000
Concrete according to ZTV Beton-StB 07 with exposed aggregate concrete surface	90	8.008
Low-noise mastic asphalt according to ZTV Asphalt-StB 07, Method B	70	8.200
Low-noise mastic asphalt according to ZTV Asphalt-StB 07, Method B	90	10.110
Paving setts or slabs with level surface (Figure 2.3.2-1) with b ≤ 5.0 mm and b+2f ≤ 9.0 mm	30	13.389
Paving setts or slabs with level surface (Figure 2.3.2-1) with b ≤ 5.0 mm and b+2f ≤ 9.0 mm	50	10.683
Other paving setts or slabs (Figure 2.3.2-1) with b > 5.0 mm or f > 2.0 mm or cobblestone pavement	30	16.837
Other paving setts or slabs (Figure 2.3.2-1) with b > 5.0 mm or f > 2.0 mm or cobblestone pavement	50	14.041

2.3.3 Rolling noise - Acceleration

Scenario R2: Rolling noise - Acceleration

Table 2.3.3-1 gives the correction terms of rolling noise $\Delta L_{WR,acc,m,k}$ for acceleration for the three vehicle categories m = 1, 2 and 3 depending on the type of road junction k = 1 or 2 and the distance x.

Table 2.3.3-1: R2, Acceleration correction of rolling noise (Source: Bundesanstalt für Straßenwesen [7])

m	k	x	$\Delta L_{WR,acc,m,k}$
-	-	m	dB
1	1	0	-4.500
1	1	50	-2.250
1	1	200	0.000
1	2	0	-4.400
1	2	50	-2.200
1	2	200	0.000
2	1	0	-4.000
2	1	50	-2.000
2	1	200	0.000
2	2	0	-2.300
2	2	50	-1.150
2	2	200	0.000
3	1	0	-4.000
3	1	50	-2.000
3	1	200	0.000
3	2	0	-2.300
3	2	50	-1.150
3	2	200	0.000

2.3.4 Rolling noise - Air temperature

Scenario R3: Rolling noise - Air temperature

Table 2.3.4-1 gives the correction terms of rolling noise $\Delta L_{WR,temp,m}$ for the air temperature τ = 15°C for the three vehicle categories m = 1, 2 and 3.

Table 2.3.4-1: R3, Air temperature correction of rolling noise (Source: Bundesanstalt für Straßenwesen [7])

m	τ	$\Delta L_{WR,temp,m}$
-	°C	dB
1	15	0.400
2	15	0.200
3	15	0.200

2.3.5 Propulsion noise - Base value

Scenario P0: Propulsion noise - Base value

Tables 2.3.5-1 to 2.3.5-8 show the sound power levels of the propulsion noise $L_{WP,i,m}$ for the frequency bands i for the three vehicle classes m = 1, 2 and 3 as a function of speed v_m. The correction terms $\Delta L_{WP,i,m}$ are set to zero here.

Table 2.3.5-1: P0.1, Base value of propulsion noise in frequency band 1 (Source: Bundesanstalt für Straßenwesen [7])

m	v_m	$L_{WP,i,m}$
-	km/h	dB
1	30	95.243
1	50	94.871
1	70	94.500
1	140	93.200
2	30	102.086
2	50	101.543
2	70	101.000
2	90	100.457
3	30	104.400
3	50	104.400
3	70	104.400
3	90	104.400

Table 2.3.5-2: P0.2, Base value of propulsion noise in frequency band 2 (Source: Bundesanstalt für Straßenwesen [7])

m	v_m	$L_{WP,i,m}$
-	km/h	dB
1	30	85.086
1	50	87.143
1	70	89.200
1	140	96.400
2	30	93.814
2	50	95.157
2	70	96.500
2	90	97.843
3	30	98.886
3	50	99.743
3	70	100.600
3	90	101.457

Table 2.3.5-3: P0.3, Base value of drive noise in frequency band 3 (Source: Bundesanstalt für Straßenwesen [7])

m	v_m	$L_{WP,i,m}$
-	km/h	dB
1	30	83.600
1	50	85.800
1	70	88.000
1	140	95.700
2	30	95.143
2	50	96.971
2	70	98.800
2	90	100.629
3	30	99.071
3	50	100.386
3	70	101.700
3	90	103.014

Table 2.3.5-4: P0.4, Base value of propulsion noise in frequency band 4 (Source: Bundesanstalt für Straßenwesen [7])

m	v_m	$L_{WP,i,m}$
-	km/h	dB
1	30	81.329
1	50	83.614
1	70	85.900
1	140	93.900
2	30	93.086
2	50	94.943
2	70	96.800
2	90	98.657
3	30	98.143
3	50	99.571
3	70	101.000
3	90	102.429

Table 2.3.5-5: P0.5, Base value of propulsion noise in frequency band 5 (Source: Bundesanstalt für Straßenwesen [7])

m	v_m	$L_{WP,i,m}$
-	km/h	dB
1	30	79.629
1	50	81.914
1	70	84.200
1	140	92.200
2	30	94.886
2	50	96.743
2	70	98.600
2	90	100.457
3	30	97.243
3	50	98.671
3	70	100.100
3	90	101.529

Table 2.3.5-6: P0.6, Base value of propulsion noise in frequency band 6 (Source: Bundesanstalt für Straßenwesen [7])

m	v_m	$L_{WP,i,m}$
-	km/h	dB
1	30	82.329
1	50	84.614
1	70	86.900
1	140	94.900
2	30	91.486
2	50	93.343
2	70	95.200
2	90	97.057
3	30	93.043
3	50	94.471
3	70	95.900
3	90	97.329

Table 2.3.5-7: P0.7, Base value of propulsion noise in frequency band 7 (Source: Bundesanstalt für Straßenwesen [7])

m	v_m	$L_{WP,i,m}$
-	km/h	dB
1	30	78.729
1	50	81.014
1	70	83.300
1	140	91.300
2	30	85.086
2	50	86.943
2	70	88.800
2	90	90.657
3	30	88.443
3	50	89.871
3	70	91.300
3	90	92.729

Table 2.3.5-8: P0.8, Base value of propulsion noise in frequency band 8 (Source: Bundesanstalt für Straßenwesen [7])

m	v_m	$L_{WP,i,m}$
-	km/h	dB
1	30	71.529
1	50	73.814
1	70	76.100
1	140	84.100
2	30	78.986
2	50	80.843
2	70	82.700
2	90	84.557
3	30	82.443
3	50	83.871
3	70	85.300
3	90	86.729

A computer program may only assume values from 30 km/h to 140 km/h for the speeds for vehicle class 1 and only values from 30 km/h to 90 km/h in steps of 10 km/h for vehicle classes 2 and 3.

2.3.6 Propulsion noise - Road surface

Scenario P1: Propulsion noise - Road surface

Tables 2.3.6-1 to 2.3.6-24 give the correction terms of the propulsion noise $\Delta L_{WP,road,i,m}$ for the road surface layer types for the three vehicle classes m= 1, 2 and 3 and the eight spectral bands i = 1 to 8 as a function of speed v_m.

Table 2.3.6-1: P1.1.1, Road surface correction of propulsion noise for Class 1 vehicles for frequency band 1 (Source: Bundesanstalt für Straßenwesen [7])

Type of road surface	v_m	$\Delta L_{WP,road,i,m}$
	km/h	dB
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	70	0.000
Porous Porousasphalt made of PA 11 according to ZTV Asphalt-StB 07	140	0.000
PorousPorous asphalt made of PA 8 according to ZTV Asphalt-StB 07	70	0.000
PorousPorous asphalt made of PA 8 according to ZTV Asphalt-StB 07	140	0.000

Table 2.3.6-2: P1.1.2, Road surface correction of propulsion noise for Class 1 vehicles for frequency band 2 (Source: Bundesanstalt für Straßenwesen [7])

Type of road surface	v_m	$\Delta L_{WP,road,i,m}$
	km/h	dB
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	70	0.000
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	140	0.000
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	70	0.000
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	140	0.000

Table 2.3.6-3: P1.1.3, Road surface correction of propulsion noise for Class 1 vehicles for frequency band 3 (Source: Bundesanstalt für Straßenwesen [7])

Type of road surface	v_m	$\Delta L_{WP,road,i,m}$
	km/h	dB
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	70	0.000
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	140	0.000
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	70	0.000
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	140	0.000

Table 2.3.6-4: P1.1.4, Road surface correction of propulsion noise for Class 1 vehicles for frequency band 4 (Source: Bundesanstalt für Straßenwesen [7])

Type of road surface	v_m	$\Delta L_{WP,road,i,m}$
	km/h	dB
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	70	0.000
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	140	0.000
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	70	0.000
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	140	0.000

Table 2.3.6-5: P1.1.5, Road surface correction of propulsion noise for Class 1 vehicles for frequency band 5 (Source: Bundesanstalt für Straßenwesen [7])

Type of road surface	v_m	$\Delta L_{WP,road,i,m}$
	km/h	dB
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	70	-0.300
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	140	-0.300
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	70	-1.700
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	140	-1.700

Table 2.3.6-6: P1.1.6, Road surface correction of propulsion noise for Class 1 vehicles for frequency band 6 (Source: Bundesanstalt für Straßenwesen [7])

Type of road surface	v_m	$\Delta L_{WP,road,i,m}$
	km/h	dB
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	70	-2.400
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	140	-2.400
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	70	-3.900
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	140	-3.900

Table 2.3.6-7: P1.1.7, Road surface correction of propulsion noise for Class 1 vehicles for frequency band 7 (Source: Bundesanstalt für Straßenwesen [7])

Type of road surface	v_m	$\Delta L_{WP,road,i,m}$
	km/h	dB
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	70	-0.900
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	140	-0.900
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	70	-3.000
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	140	-3.000

Table 2.3.6-8: P1.1.8, Road surface correction of propulsion noise for Class 1 vehicles for frequency band 8 (Source: Bundesanstalt für Straßenwesen [7])

Type of road surface	v_m	$\Delta L_{WP,road,i,m}$
	km/h	dB
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	70	0.000
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	140	0.000
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	70	0.000
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	140	0.000

Table 2.3.6-9: P1.2.1, Road surface correction of propulsion noise for Class 2 vehicles for frequency band 1 (Source: Bundesanstalt für Straßenwesen [7])

Type of road surface	v_m	$\Delta L_{WP,road,i,m}$
	km/h	dB
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	70	0.000
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	90	0.000
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	70	0.000
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	90	0.000

Table 2.3.6-10: P1.2.2, Road surface correction of propulsion noise for Class 2 vehicles for frequency band 2 (Source: Bundesanstalt für Straßenwesen [7])

Type of road surface	v_m	$\Delta L_{WP,road,i,m}$
	km/h	dB
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	70	0.000
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	90	0.000
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	70	0.000
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	90	0.000

Table 2.3.6-11: P1.2.3, Road surface correction of propulsion noise for Class 2 vehicles for frequency band 3 (Source: Bundesanstalt für Straßenwesen [7])

Type of road surface	v_m	$\Delta L_{WP,road,i,m}$
	km/h	dB
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	70	0.000
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	90	0.000
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	70	0.000
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	90	0.000

Table 2.3.6-12: P1.2.4, Road surface correction of propulsion noise for Class 2 vehicles for frequency band 4 (Source: Bundesanstalt für Straßenwesen [7])

Type of road surface	v_m	$\Delta L_{WP,road,i,m}$
	km/h	dB
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	70	0.000
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	90	0.000
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	70	0.000
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	90	0.000

Table 2.3.6-13: P1.2.5, Road surface correction of propulsion noise for Class 2 vehicles for frequency band 5 (Source: Bundesanstalt für Straßenwesen [7])

Type of road surface	v_m	$\Delta L_{WP,road,i,m}$
	km/h	dB
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	70	0.000
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	90	0.000
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	70	0.000
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	90	0.000

Table 2.3.6-14: P1.2.6, Road surface correction of propulsion noise for Class 2 vehicles for frequency band 6 (Source: Bundesanstalt für Straßenwesen [7])

Type of road surface	v_m	$\Delta L_{WP,road,i,m}$
	km/h	dB
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	70	0.000
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	90	0.000
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	70	0.000
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	90	0.000

Table 2.3.6-15: P1.2.7, Road surface correction of propulsion noise for Class 2 vehicles for frequency band 7 (Source: Bundesanstalt für Straßenwesen [7])

Type of road surface	v_m	$\Delta L_{WP,road,i,m}$
	km/h	dB
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	70	0.000
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	90	0.000
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	70	0.000
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	90	0.000

Table 2.3.6-16: P1.2.8, Road surface correction of propulsion noise for Class 2 vehicles for frequency band 8 (Source: Bundesanstalt für Straßenwesen [7])

Type of road surface	v_m	$\Delta L_{WP,road,i,m}$
	km/h	dB
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	70	0.000
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	90	0.000
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	70	0.000
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	90	0.000

Table 2.3.6-17: P1.3.1, Road surface correction of propulsion noise for Class 3 vehicles for frequency band 1 (Source: Bundesanstalt für Straßenwesen [7])

Type of road surface	v_m	$\Delta L_{WP,road,i,m}$
	km/h	dB
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	70	0.000
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	90	0.000
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	70	0.000
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	90	0.000

Table 2.3.6-18: P1.3.2, Road surface correction of propulsion noise for Class 3 vehicles for frequency band 2 (Source: Bundesanstalt für Straßenwesen [7])

Type of road surface	v_m	$\Delta L_{WP,road,i,m}$
	km/h	dB
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	70	0.000
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	90	0.000
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	70	0.000
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	90	0.000

Table 2.3.6-19: P1.3.3, Road surface correction of propulsion noise for Class 3 vehicles for frequency band 3 (Source: Bundesanstalt für Straßenwesen [7])

Type of road surface	v_m	$\Delta L_{WP,road,i,m}$
	km/h	dB
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	70	0.000
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	90	0.000
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	70	0.000
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	90	0.000

Table 2.3.6-20: P1.3.4, Road surface correction of propulsion noise for Class 3 vehicles for frequency band 4 (Source: Bundesanstalt für Straßenwesen [7])

Type of road surface	v_m	$\Delta L_{WP,road,i,m}$
	km/h	dB
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	70	0.000
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	90	0.000
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	70	0.000
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	90	0.000

Table 2.3.6-21: P1.3.5, Road surface correction of propulsion noise for Class 3 vehicles for frequency band 5 (Source: Bundesanstalt für Straßenwesen [7])

Type of road surface	v_m	$\Delta L_{WP,road,i,m}$
	km/h	dB
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	70	0.000
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	90	0.000
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	70	-0.400
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	90	-0.400

Table 2.3.6-22: P1.3.6, Road surface correction of propulsion noise for Class 3 vehicles for frequency band 6 (Source: Bundesanstalt für Straßenwesen [7])

Type of road surface	v_m	$\Delta L_{WP,road,i,m}$
	km/h	dB
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	70	0.000
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	90	0.000
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	70	0.000
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	90	0.000

Table 2.3.6-23: P1.3.7, Road surface correction of propulsion noise for Class 3 vehicles for frequency band 7 (Source: Bundesanstalt für Straßenwesen [7])

Type of road surface	v_m	$\Delta L_{WP,road,i,m}$
	km/h	dB
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	70	0.000
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	90	0.000
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	70	0.000
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	90	0.000

Table 2.3.6-24: P1.3.8, Road surface correction of propulsion noise for Class 3 vehicles for frequency band 8 (Source: Bundesanstalt für Straßenwesen [7])

Type of road surface	v_m	$\Delta L_{WP,road,i,m}$
	km/h	dB
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	70	0.000
Porous asphalt made of PA 11 according to ZTV Asphalt-StB 07	90	0.000
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	70	0.000
Porous asphalt made of PA 8 according to ZTV Asphalt-StB 07	90	0.000

2.3.7 Propulsion noise – Road Gradients

Scenario P2: Propulsion noise – Road Gradients

Tables 2.3.7-1 to 2.3.7-3 give the correction terms for the propulsion noise $\Delta L_{WP,grad,m}$ for for road gradients for the three vehicle categories = 1, 2 and 3 m as a function of the slope s and speed v_m.

Table 2.3.7-1: P2.1, Road gradient correction of propulsion noise for vehicles of category 1 (Source: Bundesanstalt für Straßenwesen [7])

s	v_m	$\Delta L_{WP,grad,m}$
%	km/h	dB
-11	30	5.000
-11	50	5.000
-11	70	5.000
-11	140	5.000
-2	30	0.000
-2	50	0.000
-2	70	0.000
-2	140	0.000
10	30	1.600
10	50	2.667
10	70	3.733
10	140	7.467

Table 2.3.7-2: P2.2, Road gradient correction of propulsion noise for vehicles of category 2 (Source: Bundesanstalt für Straßenwesen [7])

s	v	$\Delta L_{WP,grad,m}$
%	km/h	dB
-11	30	1.000
-11	50	3.000
-11	70	5.000
-11	90	7.000
-2	30	0.000
-2	50	0.000
-2	70	0.000
-2	90	0.000
10	30	3.000
10	50	5.000
10	70	7.000
10	90	9.000

Table 2.3.7-3: P2.3, Road gradient correction of propulsion noise for vehicles of category 3 (Source: Bundesanstalt für Straßenwesen [7])

s	v	$\Delta L_{WP,grad,m}$
%	km/h	dB
-11	30	2.800
-11	50	5.600
-11	70	8.400
-11	90	11.200
-2	30	0.000
-2	50	0.000
-2	70	0.000
-2	90	0.000
10	30	3.750
10	50	6.250
10	70	8.750
10	90	11.250

2.3.8 Propulsion noise - Acceleration

Scenario P3: Propulsion noise - Acceleration

Table 2.3.8-1 gives the correction terms of the propulsion noise $\Delta L_{WP,acc,m,k}$ for acceleration for the three vehicle classes m = 1, 2 and 3 depending on the type of road junction k and distance x.

Table 2.3.8-1: P3, Acceleration correction of the propulsion noise (Source: Bundesanstalt für Straßenwesen [7])

m	k	x	$\Delta L_{WP,acc,m,k}$
-	-	m	dB
1	1	0	5.500
1	1	50	2.750
1	1	200	0.000
1	2	0	3.100
1	2	50	1.550
1	2	200	0.000
2	1	0	9.000
2	1	50	4.500
2	1	200	0.000
2	2	0	6.700
2	2	50	3.350
2	2	200	0.000
3	1	0	9.000
3	1	50	4.500
3	1	200	0.000
3	2	0	6.700
3	2	50	3.350
3	2	200	0.000

2.3.9 Total noise - Base value

Scenario G0: Total noise - Base value

Tables 2.3.9-1 to 2.3.9-8 show the sound power levels of the total noise $L_{W,i,m}$ for the frequency bands i for the three vehicle categories m = 1, 2 and 3 for the reference surface layer and the national reference for non-corrugated mastic asphalt, respectively. The reference velocity v_{ref} = 70 km/h is applied with an assumed air temperature of 10°C.

Table 2.3.9-1: G0.1, Base value of the total noise in frequency band 1 (Source: Bundesanstalt für Straßenwesen [7])

m	Type of road surface	$L_{W,i,m}$
-		dB
1	Reference surface	94.670
1	Non-corrugated mastic asphalt (national reference)	94.905
2	Reference surface	101.094
2	Non-corrugated mastic asphalt (national reference)	101.915
3	Reference surface	104.486
3	Non-corrugated mastic asphalt (national reference)	105.067

Table 2.3.9-2: G0.2, Base value of the total noise in frequency band 2 (Source: Bundesanstalt für Straßenwesen [7])

m	Type of road surface	$L_{W,i,m}$
-		dB
1	Reference surface	91.067
1	Non-corrugated mastic asphalt (national reference)	92.852
2	Reference surface	97.226
2	Non-corrugated mastic asphalt (national reference)	101.198
3	Reference surface	101.174
3	Non-corrugated mastic asphalt (national reference)	103.974

Table 2.3.9-3: G0.3, Base value of the total noise in frequency band 3 (Source: Bundesanstalt für Straßenwesen [7])

m	Type of road surface	$L_{W,i,m}$
-		dB
1	Reference surface	89.867
1	Non-corrugated mastic asphalt (national reference)	91.652
2	Reference surface	99.607
2	Non-corrugated mastic asphalt (national reference)	103.835
3	Reference surface	102.457
3	Non-corrugated mastic asphalt (national reference)	105.824

Table 2.3.9-4: G0.4, Base value of the total noise in frequency band 4 (Source: Bundesanstalt für Straßenwesen [7])

m	Type of road surface	$L_{W,i,m}$
-		dB
1	Reference surface	92.169
1	Non-corrugated mastic asphalt (national reference)	95.415
2	Reference surface	99.963
2	Non-corrugated mastic asphalt (national reference)	107.763
3	Reference surface	104.061
3	Non-corrugated mastic asphalt (national reference)	110.782

Table 2.3.9-5: G0.5, Base value of the total noise in frequency band 5 (Source: Bundesanstalt für Straßenwesen [7])

m	Type of road surface	$L_{W,i,m}$
-		dB
1	Reference surface	98.273
1	Non-corrugated mastic asphalt (national reference)	102.071
2	Reference surface	101.229
2	Non-corrugated mastic asphalt (national reference)	108.562
3	Reference surface	103.695
3	Non-corrugated mastic asphalt (national reference)	110.787

Table 2.3.9-6: G0.6, Base value of the total noise in frequency band 6 (Source: Bundesanstalt für Straßenwesen [7])

m	Type of road surface	$L_{W,i,m}$
-		dB
1	Reference surface	95.367
1	Non-corrugated mastic asphalt (national reference)	98.884
2	Reference surface	96.684
2	Non-corrugated mastic asphalt (national reference)	102.496
3	Reference surface	98.352
3	Non-corrugated mastic asphalt (national reference)	104.539

Table 2.3.9-7: G0.7, Base value of the total noise in frequency band 7 (Source: Bundesanstalt für Straßenwesen [7])

m	Type of road surface	$L_{W,i,m}$
-		dB
1	Reference surface	87.184
1	Non-corrugated mastic asphalt (national reference)	89.878
2	Reference surface	90.093
2	Non-corrugated mastic asphalt (national reference)	95.535
3	Reference surface	92.813
3	Non-corrugated mastic asphalt (national reference)	97.801

Table 2.3.9-8: G0.8, Base value of the total noise in frequency band 8 (Source: Bundesanstalt für Straßenwesen [7])

m	Type of road surface	$L_{W,i,m}$
-		dB
1	Reference surface	78.639
1	Non-corrugated mastic asphalt (national reference)	80.798
2	Reference surface	84.903
2	Non-corrugated mastic asphalt (national reference)	91.774
3	Reference surface	87.274
3	Non-corrugated mastic asphalt (national reference)	92.924

2.3.10 Total noise - Sound power level per meter

Scenario G1: Total noise - Sound power level per meter

Tables 2.3.10-1 to 2.3.10-8 show the sound power levels per meter of the total noise $L_{W',eq,line,i,m}$ for the frequency bands i for the three vehicle categories m = 1, 2 and 3 for vehicle quantities Q_m = 1000 motor vehicles/h and Q_m = 10000 motor vehicles/h, respectively, and for the reference surface or the national reference for non-corrugated mastic asphalt. The reference velocity v_{ref} = 70 km/h is applied with an assumed air temperature of τ = 10°C.

Table 2.3.10-1: G1.1, Sound power level per meter of total noise in frequency band 1 (Source: Bundesanstalt für Straßenwesen [7])

m	Q_m	Type of road surface	$L_{W',eq,line,i,m}$
-	vehicle/h		dB
1	1000	Reference surface	76.219
1	10000	Reference surface	86.219
1	1000	Non-corrugated mastic asphalt (national reference)	76.454
1	10000	Non-corrugated mastic asphalt (national reference)	86.454
2	1000	Reference surface	82.643
2	10000	Reference surface	92.643
2	1000	Non-corrugated mastic asphalt (national reference)	83.464
2	10000	Non-corrugated mastic asphalt (national reference)	93.464
3	1000	Reference surface	86.035
3	10000	Reference surface	96.035
3	1000	Non-corrugated mastic asphalt (national reference)	86.616
3	10000	Non-corrugated mastic asphalt (national reference)	96.616

Table 2.3.10-2: G1.2, Sound power level per meter of total noise in frequency band 2 (Source: Bundesanstalt für Straßenwesen [7])

m	Q_m	Type of road surface	$L_{W',eq,line,i,m}$
-	vehicle/h		dB
1	1000	Reference surface	72.616
1	10000	Reference surface	82.616
1	1000	Non-corrugated mastic asphalt (national reference)	74.401
1	10000	Non-corrugated mastic asphalt (national reference)	84.401
2	1000	Reference surface	78.775
2	10000	Reference surface	88.775
2	1000	Non-corrugated mastic asphalt (national reference)	82.747
2	10000	Non-corrugated mastic asphalt (national reference)	92.747
3	1000	Reference surface	82.723
3	10000	Reference surface	92.723
3	1000	Non-corrugated mastic asphalt (national reference)	85.523
3	10000	Non-corrugated mastic asphalt (national reference)	95.523

Table 2.3.10-3: G1.3, Sound power level per meter of total noise in frequency band 3 (Source: Bundesanstalt für Straßenwesen [7])

m	Q_m	Type of road surface	$L_{W',eq,line,i,m}$
-	vehicle/h		dB
1	1000	Reference surface	71.416
1	10000	Reference surface	81.416
1	1000	Non-corrugated mastic asphalt (national reference)	73.201
1	10000	Non-corrugated mastic asphalt (national reference)	83.201
2	1000	Reference surface	81.156
2	10000	Reference surface	91.156
2	1000	Non-corrugated mastic asphalt (national reference)	85.384
2	10000	Non-corrugated mastic asphalt (national reference)	95.384
3	1000	Reference surface	84.006
3	10000	Reference surface	94.006
3	1000	Non-corrugated mastic asphalt (national reference)	87.373
3	10000	Non-corrugated mastic asphalt (national reference)	97.373

Table 2.3.10-4: G1.4, Sound power level per meter of total noise in frequency band 4 (Source: Bundesanstalt für Straßenwesen [7])

m	Q_m	Type of road surface	$L_{W',eq,line,i,m}$
-	vehicle/h		dB
1	1000	Reference surface	73.719
1	10000	Reference surface	83.719
1	1000	Non-corrugated mastic asphalt (national reference)	76.964
1	10000	Non-corrugated mastic asphalt (national reference)	86.964
2	1000	Reference surface	81.512
2	10000	Reference surface	91.512
2	1000	Non-corrugated mastic asphalt (national reference)	89.312
2	10000	Non-corrugated mastic asphalt (national reference)	99.312
3	1000	Reference surface	85.610
3	10000	Reference surface	95.610
3	1000	Non-corrugated mastic asphalt (national reference)	92.331
3	10000	Non-corrugated mastic asphalt (national reference)	102.331

Table 2.3.10-5: G1.5, Sound power level per meter of total noise in frequency band 5 (Source: Bundesanstalt für Straßenwesen [7])

m	Q_m	Type of road surface	$L_{W',eq,line,i,m}$
-	vehicle/h		dB
1	1000	Reference surface	79.822
1	10000	Reference surface	89.822
1	1000	Non-corrugated mastic asphalt (national reference)	83.621
1	10000	Non-corrugated mastic asphalt (national reference)	93.621
2	1000	Reference surface	82.778
2	10000	Reference surface	92.778
2	1000	Non-corrugated mastic asphalt (national reference)	90.111
2	10000	Non-corrugated mastic asphalt (national reference)	100.111
3	1000	Reference surface	85.244
3	10000	Reference surface	95.244
3	1000	Non-corrugated mastic asphalt (national reference)	92.337
3	10000	Non-corrugated mastic asphalt (national reference)	102.337

Table 2.3.10-6: G1.6, Sound power level per meter of total noise in frequency band 6 (Source: Bundesanstalt für Straßenwesen [7])

m	Q_m	Type of road surface	$L_{W',eq,line,i,m}$
-	vehicle/h		dB
1	1000	Reference surface	76.916
1	10000	Reference surface	86.916
1	1000	Non-corrugated mastic asphalt (national reference)	80.433
1	10000	Non-corrugated mastic asphalt (national reference)	90.433
2	1000	Reference surface	78.233
2	10000	Reference surface	88.233
2	1000	Non-corrugated mastic asphalt (national reference)	84.045
2	10000	Non-corrugated mastic asphalt (national reference)	94.045
3	1000	Reference surface	79.901
3	10000	Reference surface	89.901
3	1000	Non-corrugated mastic asphalt (national reference)	86.088
3	10000	Non-corrugated mastic asphalt (national reference)	96.088

Table 2.3.10-7: G1.7, Sound power level per meter of total noise in frequency band 7 (Source: Bundesanstalt für Straßenwesen [7])

M	Q_m	Type of road surface	$L_{W',eq,line,i,m}$
-	vehicle/h		dB
1	1000	Reference surface	68.733
1	10000	Reference surface	78.733
1	1000	Non-corrugated mastic asphalt (national reference)	71.427
1	10000	Non-corrugated mastic asphalt (national reference)	81.427
2	1000	Reference surface	71.642
2	10000	Reference surface	81.642
2	1000	Non-corrugated mastic asphalt (national reference)	77.084
2	10000	Non-corrugated mastic asphalt (national reference)	87.084
3	1000	Reference surface	74.362
3	10000	Reference surface	84.362
3	1000	Non-corrugated mastic asphalt (national reference)	79.350
3	10000	Non-corrugated mastic asphalt (national reference)	89.350

Table 2.3.10-8: G1.8, Sound power level per meter of total noise in frequency band 8 (Source: Bundesanstalt für Straßenwesen [7])

m	Q_m	Type of road surface	$L_{W',eq,line,i,m}$
-	vehicle/h		dB
1	1000	Reference surface	60.188
1	10000	Reference surface	70.188
1	1000	Non-corrugated mastic asphalt (national reference)	62.347
1	10000	Non-corrugated mastic asphalt (national reference)	72.347
2	1000	Reference surface	66.452
2	10000	Reference surface	76.452
2	1000	Non-corrugated mastic asphalt (national reference)	73.323
2	10000	Non-corrugated mastic asphalt (national reference)	83.323
3	1000	Reference surface	68.823
3	10000	Reference surface	78.823
3	1000	Non-corrugated mastic asphalt (national reference)	74.473
3	10000	Non-corrugated mastic asphalt (national reference)	84.473

2.3.11 Total noise - A-weighted total sound level

Scenario G2: Total noise - A-weighted total sound level

Table 2.3.11 shows the A-weighted sound power levels per meter $L_{W'A}$ for the three vehicle categories m = 1, 2 and 3 for vehicle quantities Q_m = 1000 vehicle/h and Q_m = 10000 vehicle/h and for the reference surface and for the national reference for non-corrugated mastic asphalt. The reference velocity v_{ref} = 70 km/h is applied with an assumed air temperature of τ = 10°C.

Table 2.3.11-1: G2, A-weighted sound power level per meter of total noise (Source: Bundesanstalt für Straßenwesen [7])

m	Q_m	Type of road surface	$L_{W'A}$
-	vehicle/h		dB(A)
1	1000	Reference surface	82.666
1	10000	Reference surface	92.666
1	1000	Non-corrugated mastic asphalt (national reference)	86.254
1	10000	Non-corrugated mastic asphalt (national reference)	96.254
2	1000	Reference surface	85.880
2	10000	Reference surface	95.880
2	1000	Non-corrugated mastic asphalt (national reference)	92.794
2	10000	Non-corrugated mastic asphalt (national reference)	102.794
3	1000	Reference surface	88.562
3	10000	Reference surface	98.562
3	1000	Non-corrugated mastic asphalt (national reference)	95.162
3	10000	Non-corrugated mastic asphalt (national reference)	105.162

3 Test scenarios for BUB, noise emission railways

3.1 Purpose

The calculation of rail transport emissions shall be carried out in accordance with [2] and [5].

The set of test cases presented in this chapter encompasses sound emissions from rail vehicles according to section 3 of Appendix 1 of the Calculation methods for environmental noise from sources close to the ground (roads, railways, industry and businesses) (BUB) [2].

3.2 Preliminary remarks

All results of the test cases in Chapter 3 are given as unweighted level values with an accuracy of three decimal places. Proof of the correctness of the test results is provided by a comparison with the specified result of the test cases. A tolerance of not more than "1" in the last decimal place is allowed. For a specified value of 1.000, for example, the calculated result may also be 0.999 or 1.001. In the test cases, only the numerical values are given, while the units are omitted.

For spectral level specifications, the octave bands listed in Appendix B of BUB with center frequencies from 50 Hz to 10 kHz are used. These frequencies are identical to the standard frequencies of EN ISO 266: 1997 Acoustics - Standard frequencies.

For the conversion of the effective total roughness for the ith wave number band in dependence of the vehicle speed v into the frequency range, reference is made in BUB to DIN CEN/TR 16891:2017-03. This procedure describes the conversion from the frequency range to the wavelength range. When used in BUB, this procedure is reversed into a conversion from the wavelength to the frequency range.

Based on the center wavelength λ_m (nominal values of the wavelength according to Appendix 4 - BUB-D Tables B-1 to B-3), the corresponding frequency is calculated as $f = \frac{v}{\lambda_m}$.

For each standard frequency f_m this conversion results in two adjacent frequencies f_- and f_+. The roughness level for a standard frequency f_m is calculated by analogy to equation (12) of DIN CEN/TR 16891:2017-03 from the level of the two adjacent frequencies f_- and f_+ to:

$$L_{r,tot,f}(f_m) = 10\lg\left(\frac{f_{c+} - f_m}{f_{c+} - f_{c-}}\, 10^{\frac{L_{r,tot}(f_{c-})}{10}} + \frac{f_m - f_{c-}}{f_{c+} - f_{c-}}\, 10^{\frac{L_{r,tot}(f_{c+})}{10}}\right)$$

Whereby:

f_m: Standard frequency according to Table 1, column 1 of EN ISO 266: 1997 Acoustics - Standard frequencies or from Appendix 4 - BUB-D Tables B-4 to B-10

f_+, f_-: Neighboring frequencies calculated from the conversion to f_m with $f_+ > f_m > f_-$

Note:
At the upper and lower edges of the speed range (50 km/h ≤ v ≤ 300 km/h), the coefficients for roughness from Appendix 4 - BUB-D in Tables B-1 to B-3 in the wavelength range are no longer sufficient. Here, the values of the final third of the upper or lower wavelength range are to be transferred to the required adjacent thirds outside the specified range.

Note:
The references to tables 3.x and equations 3.x used in chapter 3 refer to the BUB [2].

3.3 Test Cases: Sound power level $L_{W,0,A,f}$ according to equation 3.1 and $L_{W,0,B,f}$ according to equation 3.2 for a vehicle unit

3.3.1 Test Case 1.1: Determination of the sound power level $L_{W,0,A,f}$ and $L_{W,0,B,f}$ as a function of vehicle type t

For rail vehicles, Table 3.2 applies:

- Number of units of vehicle type t: *1*
- Speed: v = 100 km/h
- Measures relating to the wheels: no measure (n)

For track types according to Table 3.3:

- Superstructure: Concrete sleepers in ballast bed (B)
- Railhead roughness: average rail condition (normally maintained and smooth) (A)
- Type of rail pad: Medium (250 to 800 MN/m) (M)
- Additional measures: None (N)
- Rail joints: None (N)
- Curvature: Low (R ≥ 500m) (KN)

Vehicle type: *High speed tilting train according to Table 3.2 (h1)*

Number of axles per vehicle: *Na = 28 according to Schall 03, Supplement 1, vehicle category 4*

Brake type: *Wheel disc brake or shaft disc brake according to Table 3.2 (n)*

Table 3.3.1-1: Vehicle type (h1), brake type (n) (Source: Eisenbahnbundesamt [8])

Frequency [Hz]	$L_{W,0,rol,A}$(dB)+ C_{br}+C_{cu}	$L_{W,0,idle,A}$ (dB)	$L_{W,0,aer,A}$ (dB)	$L_{W,0,A}$ (dB)	$L_{W,0,idle,B}$ (dB)	$L_{W,0,aer,B}$ (dB)	$L_{W,0,B}$ (dB)
50	100.975	80.500	-	101.013	84.800	-	84.800
63	102.908	81.400	-	102.938	86.600	-	86.600
80	106.284	80.500	-	106.295	83.400	-	83.400
100	109.287	82.200	-	109.295	81.600	-	81.600
125	109.004	80.000	-	109.009	80.500	-	80.500
160	109.611	79.700	-	109.616	80.500	-	80.500
200	110.505	79.600	-	110.508	79.500	-	79.500
250	113.508	96.400	-	113.592	94.300	-	94.300
315	113.982	80.500	-	113.984	78.300	-	78.300
400	114.687	81.300	-	114.689	78.400	-	78.400
500	114.694	97.200	-	114.770	94.400	-	94.400
630	114.555	79.500	-	114.556	77.700	-	77.700
800	116.212	79.800	-	116.213	77.300	-	77.300
1000	116.223	86.700	-	116.227	84.600	-	84.600
1250	115.080	81.700	-	115.082	79.500	-	79.500
1600	112.501	82.700	-	112.506	81.700	-	81.700
2000	112.845	80.700	-	112.848	79.800	-	79.800
2500	113.792	78.000	-	113.793	76.900	-	76.900
3150	113.916	75.100	-	113.917	74.100	-	74.100
4000	111.312	72.100	-	111.313	71.300	-	71.300
5000	109.788	69.600	-	109.788	68.600	-	68.600
6300	107.383	66.700	-	107.383	66.000	-	66.000
8000	106.380	64.100	-	106.380	63.500	-	63.500
10000	106.078	61.800	-	106.079	61.300	-	61.300

Vehicle type: *High speed vehicle according to Table 3.2 (h2)*

Number of axles per vehicle: *Na = 32 according to Schall 03, Supplement 1, vehicle category 4*

Brake type: *Wheel disc brake or shaft disc brake according to Table 3.2 (n)*

Table 3.3.1-2: Vehicle type (h2), brake type (n) (Source: Eisenbahnbundesamt [8])

Frequency [Hz]	$L_{W,0,rol,A}$(dB)+ C_{br}+C_{cu}	$L_{W,0,idle,A}$ (dB)	$L_{W,0,aer,A}$ (dB)	$L_{W,0,A}$ (dB)	$L_{W,0,idle,B}$ (dB)	$L_{W,0,aer,B}$ (dB)	$L_{W,0,B}$ (dB)
50	101.555	80.500	-	101.589	84.800	-	84.800
63	103.488	81.400	-	103.515	86.600	-	86.600
80	106.864	80.500	-	106.874	83.400	-	83.400
100	109.867	82.200	-	109.874	81.600	-	81.600
125	109.584	80.000	-	109.588	80.500	-	80.500
160	110.191	79.700	-	110.195	80.500	-	80.500
200	111.084	79.600	-	111.088	79.500	-	79.500
250	114.088	96.400	-	114.161	94.300	-	94.300
315	114.562	80.500	-	114.564	78.300	-	78.300
400	115.267	81.300	-	115.268	78.400	-	78.400
500	115.274	97.200	-	115.341	94.400	-	94.400
630	115.135	79.500	-	115.136	77.700	-	77.700
800	116.792	79.800	-	116.793	77.300	-	77.300
1000	116.803	86.700	-	116.807	84.600	-	84.600
1250	115.660	81.700	-	115.662	79.500	-	79.500
1600	113.081	82.700	-	113.085	81.700	-	81.700
2000	113.425	80.700	-	113.427	79.800	-	79.800
2500	114.372	78.000	-	114.373	76.900	-	76.900
3150	114.496	75.100	-	114.497	74.100	-	74.100
4000	111.892	72.100	-	111.893	71.300	-	71.300
5000	110.368	69.600	-	110.368	68.600	-	68.600
6300	107.963	66.700	-	107.963	66.000	-	66.000
8000	106.960	64.100	-	106.960	63.500	-	63.500
10000	106.658	61.800	-	106.658	61.300	-	61.300

Vehicle type: *High speed power car according to Table 3.2 (h3)*

Number of axles per vehicle: *Na = 4 according to Schall 03, Supplement 1, vehicle category 1*

Brake type: *Wheel disc brake or shaft disc brake according to Table 3.2 (n)*

Table 3.3.1-3: Vehicle type (h3), brake type (n) (Source: Eisenbahnbundesamt [8])

Frequency [Hz]	$L_{W,0,rol,A}$(dB)+ C_{br}+C_{cu}	$L_{W,0,idle,A}$(dB)	$L_{W,0,aer,A}$ (dB)	$L_{W,0,A}$ (dB)	$L_{W,0,idle,B}$(dB)	$L_{W,0,aer,B}$ (dB)	$L_{W,0,B}$ (dB)
50	92.524	87.900	-	93.810	92.200	-	92.200
63	94.457	90.800	-	96.013	96.000	-	96.000
80	97.833	91.600	-	98.760	94.500	-	94.500
100	100.836	94.600	-	101.763	94.000	-	94.000
125	100.553	94.800	-	101.577	95.300	-	95.300
160	101.160	96.800	-	102.516	97.600	-	97.600
200	102.054	104.000	-	106.145	103.900	-	103.900
250	105.057	100.800	-	106.441	98.700	-	98.700
315	105.531	99.600	-	106.518	97.400	-	97.400
400	106.236	101.700	-	107.545	98.800	-	98.800
500	106.243	98.600	-	106.932	95.800	-	95.800
630	106.104	95.600	-	106.475	93.800	-	93.800
800	107.761	95.200	-	107.996	92.700	-	92.700
1000	107.772	96.100	-	108.058	94.000	-	94.000
1250	106.629	92.100	-	106.780	89.900	-	89.900
1600	104.050	89.100	-	104.187	88.100	-	88.100
2000	104.394	87.100	-	104.474	86.200	-	86.200
2500	105.341	85.400	-	105.385	84.300	-	84.300
3150	105.465	83.500	-	105.493	82.500	-	82.500
4000	102.861	81.500	-	102.893	80.700	-	80.700
5000	101.337	80.000	-	101.369	79.000	-	79.000
6300	98.932	78.100	-	98.968	77.400	-	77.400
8000	97.929	76.500	-	97.960	75.900	-	75.900
10000	97.627	75.200	-	97.652	74.700	-	74.700

Vehicle type: *High speed middle wagon/driving trailer, according to Table 3.2 (h4)*

Number of axles per vehicle: *Na = 4 according to Schall 03, Supplement 1, vehicle category 2*

Brake type: *Wheel disc brake or shaft disc brake according to Table 3.2 (n)*

Table 3.3.1-4: Vehicle type (h4), brake type (n) (Source: Eisenbahnbundesamt [8])

Frequency [Hz]	$L_{W,0,rol,A}$(dB) $+C_{br}+C_{cu}$	$L_{W,0,idle,A}$ (dB)	$L_{W,0,aer,A}$ (dB)	$L_{W,0,A}$ (dB)	$L_{W,0,idle,B}$ (dB)	$L_{W,0,aer,Bv}$ (dB)	$L_{W,0,B}$ (dB)
50	92.524	-	-	92.524	74.200	-	74.200
63	94.457	-	-	94.457	78.000	-	78.000
80	97.833	-	-	97.833	76.500	-	76.500
100	100.836	-	-	100.836	76.000	-	76.000
125	100.553	-	-	100.553	77.300	-	77.300
160	101.160	-	-	101.160	79.600	-	79.600
200	102.054	-	-	102.054	82.900	-	82.900
250	105.057	-	-	105.057	77.700	-	77.700
315	105.531	-	-	105.531	76.400	-	76.400
400	106.236	-	-	106.236	81.800	-	81.800
500	106.243	-	-	106.243	78.800	-	78.800
630	106.104	-	-	106.104	76.800	-	76.800
800	107.761	-	-	107.761	74.700	-	74.700
1000	107.772	-	-	107.772	76.000	-	76.000
1250	106.629	-	-	106.629	71.900	-	71.900
1600	104.050	-	-	104.050	70.100	-	70.100
2000	104.394	-	-	104.394	68.200	-	68.200
2500	105.341	-	-	105.341	66.300	-	66.300
3150	105.465	-	-	105.465	65.500	-	65.500
4000	102.861	-	-	102.861	63.700	-	63.700
5000	101.337	-	-	101.337	62.000	-	62.000
6300	98.932	-	-	98.932	60.400	-	60.400
8000	97.929	-	-	97.929	58.900	-	58.900
10000	97.627	-	-	97.627	57.700	-	57.700

Vehicle type: *Diesel power car according to Table 3.2 (l)*

Number of axles per vehicle: *Na = 6 according to Schall 03, Supplement 1, vehicle category 6*

Brake type: *Wheel disc brake or shaft disc brake according to Table 3.2 (n)*

Table 3.3.1-5: Vehicle type (l), brake type (n) (Source: Eisenbahnbundesamt [8])

Frequency [Hz]	$L_{W,0,rol,A}$(dB) $+C_{br}+C_{cu}$	$L_{W,0,idle,A}$ (dB)	$L_{W,0,aer,A}$ (dB)	$L_{W,0,A}$ (dB)	$L_{W,0,idle,B}$ (dB)	$L_{W,0,aer,B}$ (dB)	$L_{W,0,B}$ (dB)
50	94.285	82.600	-	94.570	86.900	-	86.900
63	96.218	82.500	-	96.398	87.700	-	87.700
80	99.594	89.300	-	99.982	92.200	-	92.200
100	102.597	90.300	-	102.846	89.700	-	89.700
125	102.253	93.500	-	102.796	94.000	-	94.000
160	102.769	99.500	-	104.445	100.300	-	100.300
200	103.566	98.700	-	104.792	98.600	-	98.600
250	106.442	95.500	-	106.778	93.400	-	93.400
315	107.214	90.300	-	107.301	88.100	-	88.100
400	108.564	91.400	-	108.647	88.500	-	88.500
500	108.807	91.300	-	108.883	88.500	-	88.500
630	108.443	90.300	-	108.509	88.500	-	88.500
800	110.021	90.900	-	110.074	88.400	-	88.400
1000	110.045	91.800	-	110.110	89.700	-	89.700
1250	108.754	92.800	-	108.863	90.600	-	90.600
1600	105.941	92.800	-	106.147	91.800	-	91.800
2000	105.371	90.800	-	105.520	89.900	-	89.900
2500	104.868	88.100	-	104.958	87.000	-	87.000
3150	104.516	85.200	-	104.567	84.200	-	84.200
4000	103.707	83.200	-	103.746	82.400	-	82.400
5000	102.009	81.700	-	102.049	80.700	-	80.700
6300	99.398	78.800	-	99.435	78.100	-	78.100
8000	98.725	76.200	-	98.749	75.600	-	75.600
10000	98.696	73.900	-	98.711	73.400	-	73.400

Vehicle type: *Electric power car according to Table 3.2 (m)*

Number of axles per vehicle: *Na = 10 according to Schall 03, Supplement 1, vehicle category 5*

Brake type: *Wheel disc brake or shaft disc brake according to Table 3.2 (n)*

Table 3.3.1-6: Vehicle type (m), brake type (n) (Source: Eisenbahnbundesamt [8])

Frequency [Hz]	$L_{W,0,rol,A}$(dB)+ C_{br}+C_{cu}	$L_{W,0,idle,A}$ (dB)	$L_{W,0,aer,A}$ (dB)	$L_{W,0,A}$ (dB)	$L_{W,0,idle,B}$ (dB)	$L_{W,0,aer,B}$ (dB)	$L_{W,0,B}$ (dB)
50	96.503	80.500	-	96.611	84.800	-	84.800
63	98.436	81.400	-	98.521	86.600	-	86.600
80	101.812	80.500	-	101.844	83.400	-	83.400
100	104.815	82.200	-	104.839	81.600	-	81.600
125	104.471	80.000	-	104.487	80.500	-	80.500
160	104.987	79.700	-	105.000	80.500	-	80.500
200	105.784	79.600	-	105.795	79.500	-	79.500
250	108.661	96.400	-	108.911	94.300	-	94.300
315	109.432	80.500	-	109.438	78.300	-	78.300
400	110.783	81.300	-	110.787	78.400	-	78.400
500	111.025	97.200	-	111.202	94.400	-	94.400
630	110.662	79.500	-	110.665	77.700	-	77.700
800	112.240	79.800	-	112.242	77.300	-	77.300
1000	112.264	86.700	-	112.276	84.600	-	84.600
1250	110.972	81.700	-	110.978	79.500	-	79.500
1600	108.160	82.700	-	108.172	81.700	-	81.700
2000	107.590	80.700	-	107.598	79.800	-	79.800
2500	107.086	78.000	-	107.092	76.900	-	76.900
3150	106.735	75.100	-	106.738	74.100	-	74.100
4000	105.926	72.100	-	105.928	71.300	-	71.300
5000	104.227	69.600	-	104.229	68.600	-	68.600
6300	101.616	66.700	-	101.618	66.000	-	66.000
8000	100.943	64.100	-	100.944	63.500	-	63.500
10000	100.915	61.800	-	100.915	61.300	-	61.300

Vehicle type: *Passenger coaches according to Table 3.2 (p)*

Number of axles per vehicle: *Na = 4 according to Schall 03, Supplement 1, vehicle category 9*

Brake type: *Wheel disc brake or shaft disc brake according to Table 3.2 (n)*

Table 3.3.1-7: Vehicle type (p), brake type (n) (Source: Eisenbahnbundesamt [8])

Frequency [Hz]	$L_{W,0,rol,A}$(dB) $+C_{br}+C_{cu}$	$L_{W,0,idle,A}$ (dB)	$L_{W,0,aer,A}$ (dB)	$L_{W,0,A}$ (dB)	$L_{W,0,idle,B}$ (dB)	$L_{W,0,aer,B}$ (dB)	$L_{W,0,B}$ (dB)
50	92.524	-	-	92.524	74.200	-	74.200
63	94.457	-	-	94.457	78.000	-	78.000
80	97.833	-	-	97.833	76.500	-	76.500
100	100.836	-	-	100.836	76.000	-	76.000
125	100.553	-	-	100.553	77.300	-	77.300
160	101.160	-	-	101.160	79.600	-	79.600
200	102.054	-	-	102.054	82.900	-	82.900
250	105.057	-	-	105.057	77.700	-	77.700
315	105.531	-	-	105.531	76.400	-	76.400
400	106.236	-	-	106.236	81.800	-	81.800
500	106.285	-	-	106.285	78.800	-	78.800
630	106.204	-	-	106.204	76.800	-	76.800
800	107.861	-	-	107.861	74.700	-	74.700
1000	107.906	-	-	107.906	76.000	-	76.000
1250	106.890	-	-	106.890	71.900	-	71.900
1600	104.450	-	-	104.450	70.100	-	70.100
2000	104.754	-	-	104.754	68.200	-	68.200
2500	105.523	-	-	105.523	66.300	-	66.300
3150	105.507	-	-	105.507	65.500	-	65.500
4000	102.961	-	-	102.961	63.700	-	63.700
5000	101.437	-	-	101.437	62.000	-	62.000
6300	99.032	-	-	99.032	60.400	-	60.400
8000	98.082	-	-	98.082	58.900	-	58.900
10000	97.827	-	-	97.827	57.700	-	57.700

Vehicle type: *Passenger coaches according to Table 3.2 (p)*

Number of axles per vehicle: *Na = 4 according to Schall 03, Supplement 1, vehicle category 9*

Brake type: *Block brake, cast iron block according to Table 3.2 (c)*

Table 3.3.1-8: Vehicle type (p), brake type (c) (Source: Eisenbahnbundesamt [8])

Frequency [Hz]	$L_{W,0,rol,A}$(dB) $+C_{br}+C_{cu}$	$L_{W,0,idle,A}$ (dB)	$L_{W,0,aer,A}$ (dB)	$L_{W,0,A}$ (dB)	$L_{W,0,idle,B}$ (dB)	$L_{W,0,aer,B}$ (dB)	$L_{W,0,B}$ (dB)
50	92.974	-	-	92.974	74.200	-	74.200
63	94.907	-	-	94.907	78.000	-	78.000
80	98.337	-	-	98.337	76.500	-	76.500
100	101.115	-	-	101.115	76.000	-	76.000
125	100.483	-	-	100.483	77.300	-	77.300
160	101.073	-	-	101.073	79.600	-	79.600
200	101.959	-	-	101.959	82.900	-	82.900
250	105.069	-	-	105.069	77.700	-	77.700
315	106.816	-	-	106.816	76.400	-	76.400
400	110.138	-	-	110.138	81.800	-	81.800
500	112.893	-	-	112.893	78.800	-	78.800
630	114.653	-	-	114.653	76.800	-	76.800
800	116.827	-	-	116.827	74.700	-	74.700
1000	116.622	-	-	116.622	76.000	-	76.000
1250	114.684	-	-	114.684	71.900	-	71.900
1600	111.085	-	-	111.085	70.100	-	70.100
2000	110.542	-	-	110.542	68.200	-	68.200
2500	110.804	-	-	110.804	66.300	-	66.300
3150	110.632	-	-	110.632	65.500	-	65.500
4000	108.058	-	-	108.058	63.700	-	63.700
5000	106.895	-	-	106.895	62.000	-	62.000
6300	105.772	-	-	105.772	60.400	-	60.400
8000	105.549	-	-	105.549	58.900	-	58.900
10000	105.815	-	-	105.815	57.700	-	57.700

Vehicle type: *Diesel loco according to Table 3.2 (d)*

Number of axles per vehicle: *Na = 4 according to Schall 03, Supplement 1, vehicle category 8*

Brake type: *Wheel disc brake or shaft disc brake according to Table 3.2 (n)*

Table 3.3.1-9: Vehicle type (p), brake type (n) (Source: Eisenbahnbundesamt [8])

Frequency [Hz]	$L_{W,0,rol,A}$(dB)+ $C_{br}+C_{cu}$	$L_{W,0,idle,A}$ (dB)	$L_{W,0,aer,A}$ (dB)	$L_{W,0,A}$ (dB)	$L_{W,0,idle,B}$ (dB)	$L_{W,0,aer,B}$ (dB)	$L_{W,0,B}$ (dB)
50	92.524	99.400	-	100.211	103.700	-	103.700
63	94.457	107.300	-	107.520	112.500	-	112.500
80	97.833	103.100	-	104.231	106.000	-	106.000
100	100.836	102.100	-	104.524	101.500	-	101.500
125	100.431	99.300	-	102.913	99.800	-	99.800
160	100.909	99.300	-	103.189	100.100	-	100.100
200	101.886	99.500	-	103.865	99.400	-	99.400
250	106.314	101.300	-	107.504	99.200	-	99.200
315	106.144	101.100	-	107.327	98.900	-	98.900
400	105.854	102.200	-	107.411	99.300	-	99.300
500	105.457	102.100	-	107.105	99.300	-	99.300
630	104.831	101.100	-	106.364	99.300	-	99.300
800	105.764	101.700	-	107.202	99.200	-	99.200
1000	105.463	101.600	-	106.958	99.500	-	99.500
1250	104.126	99.300	-	105.361	97.100	-	97.100
1600	101.048	96.000	-	102.230	95.000	-	95.000
2000	106.994	93.700	-	107.193	92.800	-	92.800
2500	106.536	101.900	-	107.820	100.800	-	100.800
3150	105.411	89.500	-	105.521	88.500	-	88.500
4000	102.139	87.100	-	102.273	86.300	-	86.300
5000	101.131	90.500	-	101.491	89.500	-	89.500
6300	99.195	81.400	-	99.266	80.700	-	80.700
8000	97.081	81.200	-	97.191	80.600	-	80.600
10000	95.902	79.600	-	96.002	79.100	-	79.100

Vehicle type: *Diesel loco according to Table 3.2 (d)*

Number of axles per vehicle: *Na = 4 according to Schall 03, Supplement 1, vehicle category 8*

Brake type: *Block brake, cast iron block according to Table 3.2 (c)*

Table 3.3.1-10: Vehicle type (d), brake type (c) (Source: Eisenbahnbundesamt [8])

Frequency [Hz]	$L_{W,0,rol,A}$(dB)+C_{br}+C_{cu}	$L_{W,0,idle,A}$ (dB)	$L_{W,0,aer,A}$ (dB)	$L_{W,0,A}$ (dB)	$L_{W,0,idle,B}$ (dB)	$L_{W,0,aer,B}$ (dB)	$L_{W,0,B}$ (dB)
50	92.974	99.400	-	100.291	103.700	-	103.700
63	94.907	107.300	-	107.543	112.500	-	112.500
80	98.337	103.100	-	104.352	106.000	-	106.000
100	101.115	102.100	-	104.646	101.500	-	101.500
125	100.361	99.300	-	102.873	99.800	-	99.800
160	100.822	99.300	-	103.138	100.100	-	100.100
200	101.791	99.500	-	103.805	99.400	-	99.400
250	106.326	101.300	-	107.513	99.200	-	99.200
315	107.381	101.100	-	108.299	98.900	-	98.900
400	109.723	102.200	-	110.431	99.300	-	99.300
500	111.983	102.100	-	112.407	99.300	-	99.300
630	113.238	101.100	-	113.496	99.300	-	99.300
800	114.728	101.700	-	114.939	99.200	-	99.200
1000	114.197	101.600	-	114.429	99.500	-	99.500
1250	111.977	99.300	-	112.205	97.100	-	97.100
1600	107.709	96.000	-	107.993	95.000	-	95.000
2000	112.731	93.700	-	112.785	92.800	-	92.800
2500	111.787	101.900	-	112.211	100.800	-	100.800
3150	110.549	89.500	-	110.583	88.500	-	88.500
4000	107.235	87.100	-	107.277	86.300	-	86.300
5000	106.648	90.500	-	106.752	89.500	-	89.500
6300	105.859	81.400	-	105.875	80.700	-	80.700
8000	104.572	81.200	-	104.592	80.600	-	80.600
10000	103.850	79.600	-	103.866	79.100	-	79.100

Vehicle type: *Electric loco according to Table 3.2 (e)*

Number of axles per vehicle: *Na = 4 according to Schall 03, Supplement 1, vehicle category 7*

Brake type: *Wheel disc brake or shaft disc brake according to Table 3.2 (n)*

Table 3.3.1-11: Vehicle type (e), brake type (n) (Source: Eisenbahnbundesamt [8])

Frequency [Hz]	$L_{W,0,rol,A}$(dB)+ C_{br}+C_{cu}	$L_{W,0,idle,A}$ (dB)	$L_{W,0,aer,A}$ (dB)	$L_{W,0,A}$ (dB)	$L_{W,0,idle,B}$ (dB)	$L_{W,0,aer,B}$ (dB)	$L_{W,0,B}$ (dB)
50	92.524	87.900	-	93.810	92.200	-	92.200
63	94.457	90.800	-	96.013	96.000	-	96.000
80	97.833	91.600	-	98.760	94.500	-	94.500
100	100.836	94.600	-	101.763	94.000	-	94.000
125	100.431	94.800	-	101.481	95.300	-	95.300
160	100.909	96.800	-	102.334	97.600	-	97.600
200	101.886	104.000	-	106.080	103.900	-	103.900
250	106.314	100.800	-	107.389	98.700	-	98.700
315	106.144	99.600	-	107.014	97.400	-	97.400
400	105.854	101.700	-	107.266	98.800	-	98.800
500	105.457	98.600	-	106.271	95.800	-	95.800
630	104.831	95.600	-	105.320	93.800	-	93.800
800	105.764	95.200	-	106.130	92.700	-	92.700
1000	105.463	96.100	-	105.939	94.000	-	94.000
1250	104.126	92.100	-	104.390	89.900	-	89.900
1600	101.048	89.100	-	101.317	88.100	-	88.100
2000	106.994	87.100	-	107.039	86.200	-	86.200
2500	106.536	85.400	-	106.569	84.300	-	84.300
3150	105.411	83.500	-	105.439	82.500	-	82.500
4000	102.139	81.500	-	102.176	80.700	-	80.700
5000	101.131	80.000	-	101.164	79.000	-	79.000
6300	99.195	78.100	-	99.228	77.400	-	77.400
8000	97.081	76.500	-	97.118	75.900	-	75.900
10000	95.902	75.200	-	95.939	74.700	-	74.700

Vehicle type: *Electric loco according to Table 3.2 (e)*

Number of axles per vehicle: *Na = 4 according to Schall 03, Supplement 1, vehicle category 7*

Brake type: *Block brake, cast iron block according to Table 3.2 (c)*

Table 3.3.1-12: Vehicle type (e), brake type (c) (Source: Eisenbahnbundesamt [8])

Frequency [Hz]	$L_{W,0,rol,A}$(dB)+ C_{br}+C_{cu}	$L_{W,0,idle,A}$ (dB)	$L_{W,0,aer,A}$ (dB)	$L_{W,0,A}$ (dB)	$L_{W,0,idle,B}$ (dB)	$L_{W,0,aer,B}$ (dB)	$L_{W,0,B}$ (dB)
50	92.974	87.900	-	94.149	92.200	-	92.200
63	94.907	90.800	-	96.332	96.000	-	96.000
80	98.337	91.600	-	99.172	94.500	-	94.500
100	101.115	94.600	-	101.990	94.000	-	94.000
125	100.361	94.800	-	101.426	95.300	-	95.300
160	100.822	96.800	-	102.271	97.600	-	97.600
200	101.791	104.000	-	106.045	103.900	-	103.900
250	106.326	100.800	-	107.398	98.700	-	98.700
315	107.381	99.600	-	108.051	97.400	-	97.400
400	109.723	101.700	-	110.359	98.800	-	98.800
500	111.983	98.600	-	112.178	95.800	-	95.800
630	113.238	95.600	-	113.313	93.800	-	93.800
800	114.728	95.200	-	114.776	92.700	-	92.700
1000	114.197	96.100	-	114.264	94.000	-	94.000
1250	111.977	92.100	-	112.021	89.900	-	89.900
1600	107.709	89.100	-	107.769	88.100	-	88.100
2000	112.731	87.100	-	112.743	86.200	-	86.200
2500	111.787	85.400	-	111.797	84.300	-	84.300
3150	110.549	83.500	-	110.558	82.500	-	82.500
4000	107.235	81.500	-	107.247	80.700	-	80.700
5000	106.648	80.000	-	106.658	79.000	-	79.000
6300	105.859	78.100	-	105.866	77.400	-	77.400
8000	104.572	76.500	-	104.578	75.900	-	75.900
10000	103.850	75.200	-	103.856	74.700	-	74.700

Vehicle type: *Freight vehicles according to Table 3.2 (a)*

Number of axles per vehicle: *Na = 4 according to Schall 03, Supplement 1, vehicle category 10*

Brake type: *Wheel disc brake or shaft disc brake according to Table 3.2 (n)*

Table 3.3.1-13: Vehicle type (a), brake type (n) (Source: Eisenbahnbundesamt [8])

Frequency [Hz]	$L_{W,0,rol,A}$(dB)+ C_{br}+C_{cu}	$L_{W,0,idle,A}$ (dB)	$L_{W,0,aer,A}$ (dB)	$L_{W,0,A}$ (dB)	$L_{W,0,idle,B}$ (dB)	$L_{W,0,aer,B}$ (dB)	$L_{W,0,B}$ (dB)
50	92.524	-	-	92.524	-	-	-
63	94.457	-	-	94.457	-	-	-
80	97.833	-	-	97.833	-	-	-
100	100.836	-	-	100.836	-	-	-
125	100.553	-	-	100.553	-	-	-
160	101.160	-	-	101.160	-	-	-
200	102.054	-	-	102.054	-	-	-
250	105.057	-	-	105.057	-	-	-
315	105.531	-	-	105.531	-	-	-
400	106.236	-	-	106.236	-	-	-
500	106.285	-	-	106.285	-	-	-
630	106.204	-	-	106.204	-	-	-
800	107.861	-	-	107.861	-	-	-
1000	107.906	-	-	107.906	-	-	-
1250	106.890	-	-	106.890	-	-	-
1600	104.450	-	-	104.450	-	-	-
2000	104.754	-	-	104.754	-	-	-
2500	105.523	-	-	105.523	-	-	-
3150	105.507	-	-	105.507	-	-	-
4000	102.961	-	-	102.961	-	-	-
5000	101.437	-	-	101.437	-	-	-
6300	99.032	-	-	99.032	-	-	-
8000	98.082	-	-	98.082	-	-	-
10000	97.827	-	-	97.827	-	-	-

Vehicle type: *Freight vehicles according to Table 3.2 (a)*

Number of axles per vehicle: *Na = 4 according to Schall 03, Supplement 1, vehicle category 10*

Brake type: *Block brake, cast iron block according to Table 3.2 (c)*

Table 3.3.1-14: Vehicle type (a), brake type (c) (Source: Eisenbahnbundesamt [8])

Frequency [Hz]	$L_{W,0,rol,A}$(dB)+ C_{br}+C_{cu}	$L_{W,0,idle,A}$ (dB)	$L_{W,0,aer,A}$ (dB)	$L_{W,0,A}$ (dB)	$L_{W,0,idle,B}$ (dB)	$L_{W,0,aer,B}$ (dB)	$L_{W,0,B}$ (dB)
50	92.974	-	-	92.974	-	-	-
63	94.907	-	-	94.907	-	-	-
80	98.337	-	-	98.337	-	-	-
100	101.115	-	-	101.115	-	-	-
125	100.483	-	-	100.483	-	-	-
160	101.073	-	-	101.073	-	-	-
200	101.959	-	-	101.959	-	-	-
250	105.069	-	-	105.069	-	-	-
315	106.816	-	-	106.816	-	-	-
400	110.138	-	-	110.138	-	-	-
500	112.893	-	-	112.893	-	-	-
630	114.653	-	-	114.653	-	-	-
800	116.827	-	-	116.827	-	-	-
1000	116.622	-	-	116.622	-	-	-
1250	114.684	-	-	114.684	-	-	-
1600	111.085	-	-	111.085	-	-	-
2000	110.542	-	-	110.542	-	-	-
2500	110.804	-	-	110.804	-	-	-
3150	110.632	-	-	110.632	-	-	-
4000	108.058	-	-	108.058	-	-	-
5000	106.895	-	-	106.895	-	-	-
6300	105.772	-	-	105.772	-	-	-
8000	105.549	-	-	105.549	-	-	-
10000	105.815	-	-	105.815	-	-	-

Vehicle type: *Freight vehicles according to Table 3.2 (a)*

Number of axles per vehicle: *Na = 4 according to Schall 03, Supplement 1, vehicle category 10*

Brake type: *Block brake, composite block according to Table 3.2 (k)*

Table 3.3.1-15: Vehicle type (a), brake type (k) (Source: Eisenbahnbundesamt [8])

Frequency [Hz]	$L_{W,0,rol,A}$(dB)+ C_{br}+C_{cu}	$L_{W,0,idle,A}$ (dB)	$L_{W,0,aer,A}$ (dB)	$L_{W,0,A}$ (dB)	$L_{W,0,idle,B}$ (dB)	$L_{W,0,aer,B}$ (dB)	$L_{W,0,B}$ (dB)
50	92.571	-	-	92.571	-	-	-
63	94.504	-	-	94.504	-	-	-
80	97.886	-	-	97.886	-	-	-
100	100.565	-	-	100.565	-	-	-
125	99.810	-	-	99.810	-	-	-
160	100.206	-	-	100.206	-	-	-
200	101.130	-	-	101.130	-	-	-
250	104.019	-	-	104.019	-	-	-
315	104.319	-	-	104.319	-	-	-
400	105.183	-	-	105.183	-	-	-
500	105.402	-	-	105.402	-	-	-
630	105.534	-	-	105.534	-	-	-
800	107.416	-	-	107.416	-	-	-
1000	107.727	-	-	107.727	-	-	-
1250	107.008	-	-	107.008	-	-	-
1600	104.810	-	-	104.810	-	-	-
2000	105.264	-	-	105.264	-	-	-
2500	106.241	-	-	106.241	-	-	-
3150	106.548	-	-	106.548	-	-	-
4000	104.308	-	-	104.308	-	-	-
5000	103.238	-	-	103.238	-	-	-
6300	102.267	-	-	102.267	-	-	-
8000	102.765	-	-	102.765	-	-	-
10000	102.914	-	-	102.914	-	-	-

3.3.2 Test Case 1.2: Determination of the sound power level $L_{W,0,A,f}$ or $L_{W,0,B,f}$ as a function of speed v - High speed railcar

For rail vehicles, Table 3.2 applies:

- Number of units of vehicle type t: *1*
- Vehicle type: *High speed vehicle according to Table 3.2 (h2)*
- Number of axles per vehicle: *Na = 32 according to Schall 03, Supplement 1, vehicle category 4*
- Brake type: *Wheel disc brake or shaft disc brake according to Table 3.2 (n)*
- Measures relating to the wheels: no measure (n)

For track type according to Table 3.3:

- Superstructure: Concrete sleepers in ballast bed (B)
- Railhead roughness: average rail condition (normally maintained and smooth) (A)
- Type of rail pad: Medium (250 to 800 MN/m) (M)
- Additional measures: None (N)
- Rail joints: None (N)
- Curvature: Low (R ≥ 500m) (KN)

Speed v = 70 km/h

Table 3.3.2-1: Speed v = 70 km/h (Source: Eisenbahnbundesamt [8])

Frequency [Hz]	$L_{W,0,rol,A}$(dB)+ C_{br}+C_{cu}	$L_{W,0,idle,A}$ (dB)	$L_{W,0,aer,A}$ (dB)	$L_{W,0,A}$ (dB)	$L_{W,0,idle,B}$ (dB)	$L_{W,0,aer,B}$ (dB)	$L_{W,0,B}$ (dB)
50	101.461	80.500	-	101.496	84.800	-	84.800
63	102.489	81.400	-	102.523	86.600	-	86.600
80	106.067	80.500	-	106.079	83.400	-	83.400
100	108.955	82.200	-	108.964	81.600	-	81.600
125	108.321	80.000	-	108.327	80.500	-	80.500
160	108.708	79.700	-	108.714	80.500	-	80.500
200	109.983	79.600	-	109.987	79.500	-	79.500
250	112.568	96.400	-	112.671	94.300	-	94.300
315	112.504	80.500	-	112.507	78.300	-	78.300
400	112.761	81.300	-	112.764	78.400	-	78.400
500	112.472	97.200	-	112.599	94.400	-	94.400
630	111.526	79.500	-	111.529	77.700	-	77.700
800	112.144	79.800	-	112.146	77.300	-	77.300
1000	111.081	86.700	-	111.097	84.600	-	84.600
1250	109.978	81.700	-	109.985	79.500	-	79.500
1600	108.911	82.700	-	108.921	81.700	-	81.700
2000	110.231	80.700	-	110.236	79.800	-	79.800
2500	111.085	78.000	-	111.087	76.900	-	76.900
3150	111.469	75.100	-	111.470	74.100	-	74.100
4000	108.145	72.100	-	108.146	71.300	-	71.300
5000	106.792	69.600	-	106.793	68.600	-	68.600
6300	106.144	66.700	-	106.144	66.000	-	66.000
8000	105.070	64.100	-	105.070	63.500	-	63.500
10000	104.479	61.800	-	104.479	61.300	-	61.300

Speed v = 100 km/h

Table 3.3.2-2: Speed v = 100 km/h (Source: Eisenbahnbundesamt [8])

Frequency [Hz]	$L_{W,0,rol,A}$(dB)+ C_{br}+C_{cu}	$L_{W,0,idle,A}$ (dB)	$L_{W,0,aer,A}$ (dB)	$L_{W,0,A}$ (dB)	$L_{W,0,idle,B}$ (dB)	$L_{W,0,aer,B}$ (dB)	$L_{W,0,B}$ (dB)
50	101.555	80.500	-	101.589	84.800	-	84.800
63	103.488	81.400	-	103.515	86.600	-	86.600
80	106.864	80.500	-	106.874	83.400	-	83.400
100	109.867	82.200	-	109.874	81.600	-	81.600
125	109.584	80.000	-	109.588	80.500	-	80.500
160	110.191	79.700	-	110.195	80.500	-	80.500
200	111.084	79.600	-	111.088	79.500	-	79.500
250	114.088	96.400	-	114.161	94.300	-	94.300
315	114.562	80.500	-	114.564	78.300	-	78.300
400	115.267	81.300	-	115.268	78.400	-	78.400
500	115.274	97.200	-	115.341	94.400	-	94.400
630	115.135	79.500	-	115.136	77.700	-	77.700
800	116.792	79.800	-	116.793	77.300	-	77.300
1000	116.803	86.700	-	116.807	84.600	-	84.600
1250	115.660	81.700	-	115.662	79.500	-	79.500
1600	113.081	82.700	-	113.085	81.700	-	81.700
2000	113.425	80.700	-	113.427	79.800	-	79.800
2500	114.372	78.000	-	114.373	76.900	-	76.900
3150	114.496	75.100	-	114.497	74.100	-	74.100
4000	111.892	72.100	-	111.893	71.300	-	71.300
5000	110.368	69.600	-	110.368	68.600	-	68.600
6300	107.963	66.700	-	107.963	66.000	-	66.000
8000	106.960	64.100	-	106.960	63.500	-	63.500
10000	106.658	61.800	-	106.658	61.300	-	61.300

Speed v = 150 km/h

Table 3.3.2-3: Speed v = 150 km/h (Source: Eisenbahnbundesamt [8])

Frequency [Hz]	$L_{W,0,rol,A}$(dB)+ C_{br}+C_{cu}	$L_{W,0,idle,A}$ (dB)	$L_{W,0,aer,A}$ (dB)	$L_{W,0,A}$ (dB)	$L_{W,0,idle,B}$ (dB)	$L_{W,0,aer,B}$ (dB)	$L_{W,0,B}$ (dB)
50	101.555	80.500	-	101.589	84.800	-	84.800
63	103.488	81.400	-	103.515	86.600	-	86.600
80	107.387	80.500	-	107.396	83.400	-	83.400
100	110.981	82.200	-	110.987	81.600	-	81.600
125	110.461	80.000	-	110.465	80.500	-	80.500
160	111.409	79.700	-	111.412	80.500	-	80.500
200	112.597	79.600	-	112.600	79.500	-	79.500
250	115.580	96.400	-	115.632	94.300	-	94.300
315	115.897	80.500	-	115.898	78.300	-	78.300
400	117.241	81.300	-	117.243	78.400	-	78.400
500	117.689	97.200	-	117.727	94.400	-	94.400
630	117.996	79.500	-	117.996	77.700	-	77.700
800	120.122	79.800	-	120.123	77.300	-	77.300
1000	121.069	86.700	-	121.071	84.600	-	84.600
1250	120.999	81.700	-	120.999	79.500	-	79.500
1600	119.250	82.700	-	119.251	81.700	-	81.700
2000	118.861	80.700	-	118.862	79.800	-	79.800
2500	118.451	78.000	-	118.451	76.900	-	76.900
3150	117.997	75.100	-	117.997	74.100	-	74.100
4000	115.367	72.100	-	115.367	71.300	-	71.300
5000	113.807	69.600	-	113.807	68.600	-	68.600
6300	112.084	66.700	-	112.084	66.000	-	66.000
8000	109.989	64.100	-	109.989	63.500	-	63.500
10000	108.510	61.800	-	108.510	61.300	-	61.300

Speed v = 300 km/h

Table 3.3.2-4: Speed v = 300 km/h (Source: Eisenbahnbundesamt [8])

Frequency [Hz]	$L_{W,0,rol,A}$(dB)+ C_{br}+C_{cu}	$L_{W,0,idle,A}$ (dB)	$L_{W,0,aer,A}$ (dB)	$L_{W,0,A}$ (dB)	$L_{W,0,idle,B}$ (dB)	$L_{W,0,aer,B}$ (dB)	$L_{W,0,B}$ (dB)
50	101.555	80.500	112.600	112.931	84.800	36.700	84.800
63	103.488	81.400	113.200	113.643	86.600	38.500	86.600
80	107.387	80.500	115.700	116.299	83.400	39.000	83.400
100	110.981	82.200	117.400	118.293	81.600	37.500	81.600
125	111.164	80.000	115.300	116.718	80.500	36.800	80.500
160	112.602	79.700	115.000	116.976	80.500	37.100	80.500
200	114.391	79.600	114.900	117.664	79.500	36.400	79.500
250	117.447	96.400	116.400	119.985	94.300	36.200	94.300
315	118.265	80.500	115.900	120.252	78.300	35.900	78.300
400	119.645	81.300	116.300	121.298	78.400	36.300	78.400
500	120.315	97.200	116.200	121.753	94.400	36.300	94.400
630	120.932	79.500	115.200	121.961	77.700	36.300	77.700
800	124.056	79.800	115.800	124.661	77.300	36.200	77.300
1000	125.682	86.700	115.700	126.098	84.600	36.500	84.600
1250	126.521	81.700	115.700	126.867	79.500	36.400	79.500
1600	126.154	82.700	114.700	126.454	81.700	105.200	105.219
2000	127.541	80.700	114.700	127.762	79.800	110.300	110.304
2500	128.405	78.000	115.000	128.599	76.900	110.400	110.402
3150	127.680	75.100	114.500	127.884	74.100	105.600	105.603
4000	123.396	72.100	113.100	123.784	71.300	37.200	71.302
5000	120.484	69.600	112.100	121.072	68.600	37.500	68.603
6300	118.005	66.700	110.600	118.731	66.000	37.900	66.007
8000	116.344	64.100	109.600	117.178	63.500	38.400	63.513
10000	114.984	61.800	108.800	115.921	61.300	39.200	61.327

3.3.3 Test Case 1.3: Determination of the sound power level $L_{W,0,A,f}$ or $L_{W,0,B,f}$ as a function of speed v - Freight train

For rail vehicles, Table 3.2 applies:

- Number of units of vehicle type t: *1*
- Vehicle type: *Freight vehicles according to Table 3.2 (a)*
- Number of axles per vehicle: *Na = 4 according to Schall 03, Supplement 1, vehicle category 10*
- Brake type: *Block brake, composite block according to Table 3.2 (k)*
- Measures relating to the wheels: no measure (n)

For track type according to Table 3.3:

- Superstructure: Concrete sleepers in ballast bed (B)
- Railhead roughness: average rail condition (normally maintained and smooth) (A)
- Type of rail pad: Medium (250 to 800 MN/m) (M)
- Additional measures: None (N)
- Rail joints: None (N)
- Curvature: Low (R ≥ 500m) (KN)

Speed v = 70 km/h

Table 3.3.3-1: Speed v = 70 km/h (Source: Eisenbahnbundesamt [8])

Frequency [Hz]	$L_{W,0,rol,A}$(dB)+ C_{br}+C_{cu}	$L_{W,0,idle,A}$ (dB)	$L_{W,0,aer,A}$ (dB)	$L_{W,0,A}$ (dB)	$L_{W,0,idle,B}$ (dB)	$L_{W,0,aer,B}$ (dB)	$L_{W,0,B}$ (dB)
50	92.479	-	-	92.479	-	-	-
63	93.470	-	-	93.470	-	-	-
80	96.383	-	-	96.383	-	-	-
100	99.031	-	-	99.031	-	-	-
125	98.292	-	-	98.292	-	-	-
160	98.804	-	-	98.804	-	-	-
200	99.682	-	-	99.682	-	-	-
250	102.418	-	-	102.418	-	-	-
315	102.520	-	-	102.520	-	-	-
400	103.082	-	-	103.082	-	-	-
500	103.006	-	-	103.006	-	-	-
630	102.311	-	-	102.311	-	-	-
800	103.378	-	-	103.378	-	-	-
1000	102.747	-	-	102.747	-	-	-
1250	101.807	-	-	101.807	-	-	-
1600	100.770	-	-	100.770	-	-	-
2000	102.146	-	-	102.146	-	-	-
2500	103.387	-	-	103.387	-	-	-
3150	104.072	-	-	104.072	-	-	-
4000	101.691	-	-	101.691	-	-	-
5000	102.208	-	-	102.208	-	-	-
6300	102.349	-	-	102.349	-	-	-
8000	101.434	-	-	101.434	-	-	-
10000	101.194	-	-	101.194	-	-	-

Speed v = 100 km/h

Table 3.3.3-2: Speed v = 100 km/h (Source: Eisenbahnbundesamt [8])

Frequency [Hz]	$L_{W,0,rol,A}$(dB)+ C_{br}+C_{cu}	$L_{W,0,idle,A}$ (dB)	$L_{W,0,aer,A}$ (dB)	$L_{W,0,A}$ (dB)	$L_{W,0,idle,B}$ (dB)	$L_{W,0,aer,B}$ (dB)	$L_{W,0,B}$ (dB)
50	92.571	-	-	92.571	-	-	-
63	94.504	-	-	94.504	-	-	-
80	97.886	-	-	97.886	-	-	-
100	100.565	-	-	100.565	-	-	-
125	99.810	-	-	99.810	-	-	-
160	100.206	-	-	100.206	-	-	-
200	101.130	-	-	101.130	-	-	-
250	104.019	-	-	104.019	-	-	-
315	104.319	-	-	104.319	-	-	-
400	105.183	-	-	105.183	-	-	-
500	105.402	-	-	105.402	-	-	-
630	105.534	-	-	105.534	-	-	-
800	107.416	-	-	107.416	-	-	-
1000	107.727	-	-	107.727	-	-	-
1250	107.008	-	-	107.008	-	-	-
1600	104.810	-	-	104.810	-	-	-
2000	105.264	-	-	105.264	-	-	-
2500	106.241	-	-	106.241	-	-	-
3150	106.548	-	-	106.548	-	-	-
4000	104.308	-	-	104.308	-	-	-
5000	103.238	-	-	103.238	-	-	-
6300	102.267	-	-	102.267	-	-	-
8000	102.765	-	-	102.765	-	-	-
10000	102.914	-	-	102.914	-	-	-

Speed v = 120 km/h

Table 3.3.3-3: Speed v = 120 km/h (Source: Eisenbahnbundesamt [8])

Frequency [Hz]	$L_{W,0,rol,A}$(dB)+ C_{br}+C_{cu}	$L_{W,0,idle,A}$ (dB)	$L_{W,0,aer,A}$ (dB)	$L_{W,0,A}$ (dB)	$L_{W,0,idle,B}$ (dB)	$L_{W,0,aer,B}$ (dB)	$L_{W,0,B}$ (dB)
50	92.571	-	-	92.571	-	-	-
63	94.504	-	-	94.504	-	-	-
80	98.404	-	-	98.404	-	-	-
100	101.303	-	-	101.303	-	-	-
125	100.570	-	-	100.570	-	-	-
160	100.956	-	-	100.956	-	-	-
200	101.808	-	-	101.808	-	-	-
250	104.728	-	-	104.728	-	-	-
315	105.100	-	-	105.100	-	-	-
400	106.042	-	-	106.042	-	-	-
500	106.407	-	-	106.407	-	-	-
630	106.677	-	-	106.677	-	-	-
800	108.906	-	-	108.906	-	-	-
1000	109.603	-	-	109.603	-	-	-
1250	109.305	-	-	109.305	-	-	-
1600	107.291	-	-	107.291	-	-	-
2000	107.217	-	-	107.217	-	-	-
2500	107.833	-	-	107.833	-	-	-
3150	107.952	-	-	107.952	-	-	-
4000	105.476	-	-	105.476	-	-	-
5000	104.544	-	-	104.544	-	-	-
6300	102.875	-	-	102.875	-	-	-
8000	102.667	-	-	102.667	-	-	-
10000	103.496	-	-	103.496	-	-	-

3.3.4 Test Case 1.4: Determination of the sound power level $L_{W,0,A,f}$ or $L_{W,0,B,f}$ as a function of the type of superstructure - High speed railcar

For rail vehicles, Table 3.2 applies:

- Number of units of vehicle type t: *1*
- Vehicle type: *High speed vehicle according to Table 3.2 (h2)*
- Number of axles per vehicle: *Na = 32 according to Schall 03, Supplement 1, vehicle category 4*
- Brake type: *Wheel disc brake or shaft disc brake according to Table 3.2 (n)*
- Speed v = 300 km/h
- Measures relating to the wheels: no measure (n)

For track type according to Table 3.3:

- Railhead roughness: average rail condition (normally maintained and smooth) (A)
- Type of rail pad: Medium (250 to 800 MN/m) (M)
- Additional measures: None (N)
- Rail joints: None (N)
- Curvature: Low (R ≥ 500m) (KN)

Superstructure: Wooden sleepers in ballast bed, according to Table 3.3, (H)

Table 3.3.4-1: Superstructure (H) (Source: Eisenbahnbundesamt [8])

Frequency [Hz]	$L_{W,0,rol,A}$(dB)+ C_{br}+C_{cu}	$L_{W,0,idle,A}$ (dB)	$L_{W,0,aer,A}$ (dB)	$L_{W,0,A}$ (dB)	$L_{W,0,idle,B}$ (dB)	$L_{W,0,aer,B}$ (dB)	$L_{W,0,B}$ (dB)
50	101.555	80.500	112.600	112.931	84.800	36.700	84.800
63	103.488	81.400	113.200	113.643	86.600	38.500	86.600
80	107.387	80.500	115.700	116.299	83.400	39.000	83.400
100	110.981	82.200	117.400	118.293	81.600	37.500	81.600
125	111.164	80.000	115.300	116.718	80.500	36.800	80.500
160	112.602	79.700	115.000	116.976	80.500	37.100	80.500
200	114.391	79.600	114.900	117.664	79.500	36.400	79.500
250	117.447	96.400	116.400	119.985	94.300	36.200	94.300
315	118.265	80.500	115.900	120.252	78.300	35.900	78.300
400	119.645	81.300	116.300	121.298	78.400	36.300	78.400
500	120.315	97.200	116.200	121.753	94.400	36.300	94.400
630	120.932	79.500	115.200	121.961	77.700	36.300	77.700
800	124.056	79.800	115.800	124.661	77.300	36.200	77.300
1000	125.682	86.700	115.700	126.098	84.600	36.500	84.600
1250	126.521	81.700	115.700	126.867	79.500	36.400	79.500
1600	126.154	82.700	114.700	126.454	81.700	105.200	105.219
2000	127.541	80.700	114.700	127.762	79.800	110.300	110.304
2500	128.405	78.000	115.000	128.599	76.900	110.400	110.402
3150	127.680	75.100	114.500	127.884	74.100	105.600	105.603
4000	123.396	72.100	113.100	123.784	71.300	37.200	71.302
5000	120.484	69.600	112.100	121.072	68.600	37.500	68.603
6300	118.005	66.700	110.600	118.731	66.000	37.900	66.007
8000	116.344	64.100	109.600	117.178	63.500	38.400	63.513
10000	114.984	61.800	108.800	115.921	61.300	39.200	61.327

Superstructure: *Solid roadway, according to Table 3.3, (S)*

Table 3.3.4-2: Superstructure (S) (Source: Eisenbahnbundesamt [8])

Frequency [Hz]	$L_{W,0,rol,A}$(dB)+ C_{br}+C_{cu}	$L_{W,0,idle,A}$ (dB)	$L_{W,0,aer,A}$ (dB)	$L_{W,0,A}$ (dB)	$L_{W,0,idle,B}$ (dB)	$L_{W,0,aer,B}$ (dB)	$L_{W,0,B}$ (dB)
50	101.559	80.500	112.600	112.931	84.800	36.700	84.800
63	103.500	81.400	113.200	113.645	86.600	38.500	86.600
80	107.425	80.500	115.700	116.303	83.400	39.000	83.400
100	111.154	82.200	117.400	118.326	81.600	37.500	81.600
125	111.578	80.000	115.300	116.837	80.500	36.800	80.500
160	113.114	79.700	115.000	117.170	80.500	37.100	80.500
200	114.987	79.600	114.900	117.955	79.500	36.400	79.500
250	118.103	96.400	116.400	120.362	94.300	36.200	94.300
315	118.966	80.500	115.900	120.709	78.300	35.900	78.300
400	125.193	81.300	116.300	125.720	78.400	36.300	78.400
500	126.047	97.200	116.200	126.480	94.400	36.300	94.400
630	126.821	79.500	115.200	127.110	77.700	36.300	77.700
800	127.619	79.800	115.800	127.896	77.300	36.200	77.300
1000	129.287	86.700	115.700	129.474	84.600	36.500	84.600
1250	129.869	81.700	115.700	130.032	79.500	36.400	79.500
1600	126.909	82.700	114.700	127.163	81.700	105.200	105.219
2000	128.082	80.700	114.700	128.277	79.800	110.300	110.304
2500	128.724	78.000	115.000	128.904	76.900	110.400	110.402
3150	127.888	75.100	114.500	128.083	74.100	105.600	105.603
4000	123.649	72.100	113.100	124.016	71.300	37.200	71.302
5000	120.737	69.600	112.100	121.294	68.600	37.500	68.603
6300	118.254	66.700	110.600	118.942	66.000	37.900	66.007
8000	116.593	64.100	109.600	117.384	63.500	38.400	63.513
10000	115.233	61.800	108.800	116.123	61.300	39.200	61.327

Superstructure: *Concrete bridge, sleeper track in ballast bed, according to Table 3.3, (LB)*

Table 3.3.4-3: Superstructure (LB) (Source: Eisenbahnbundesamt [8])

Frequency [Hz]	$L_{W,0,rol,A}$(dB)+ C_{br}+C_{cu}	$L_{W,0,idle,A}$ (dB)	$L_{W,0,aer,A}$ (dB)	$L_{W,0,A}$ (dB)	$L_{W,0,idle,B}$ (dB)	$L_{W,0,aer,B}$ (dB)	$L_{W,0,B}$ (dB)
50	104.555	80.500	112.600	113.235	84.800	36.700	84.800
63	106.488	81.400	113.200	114.042	86.600	38.500	86.600
80	110.387	80.500	115.700	116.821	83.400	39.000	83.400
100	113.981	82.200	117.400	119.030	81.600	37.500	81.600
125	114.164	80.000	115.300	117.780	80.500	36.800	80.500
160	115.602	79.700	115.000	118.322	80.500	37.100	80.500
200	117.391	79.600	114.900	119.332	79.500	36.400	79.500
250	120.447	96.400	116.400	121.902	94.300	36.200	94.300
315	121.265	80.500	115.900	122.374	78.300	35.900	78.300
400	122.645	81.300	116.300	123.552	78.400	36.300	78.400
500	123.315	97.200	116.200	124.095	94.400	36.300	94.400
630	123.932	79.500	115.200	124.478	77.700	36.300	77.700
800	127.056	79.800	115.800	127.370	77.300	36.200	77.300
1000	128.682	86.700	115.700	128.895	84.600	36.500	84.600
1250	129.521	81.700	115.700	129.698	79.500	36.400	79.500
1600	129.154	82.700	114.700	129.307	81.700	105.200	105.219
2000	130.541	80.700	114.700	130.653	79.800	110.300	110.304
2500	131.405	78.000	115.000	131.503	76.900	110.400	110.402
3150	130.680	75.100	114.500	130.783	74.100	105.600	105.603
4000	126.396	72.100	113.100	126.595	71.300	37.200	71.302
5000	123.484	69.600	112.100	123.788	68.600	37.500	68.603
6300	121.005	66.700	110.600	121.384	66.000	37.900	66.007
8000	119.344	64.100	109.600	119.782	63.500	38.400	63.513
10000	117.984	61.800	108.800	118.479	61.300	39.200	61.327

Superstructure: *Steel bridge, sleeper track in ballast bed, according to Table 3.3, (LS)*

Table 3.3.4-4: Superstructure (LS) (Source: Eisenbahnbundesamt [8])

Frequency [Hz]	$L_{W,0,rol,A}$(dB)+ C_{br}+C_{cu}	$L_{W,0,idle,A}$ (dB)	$L_{W,0,aer,A}$ (dB)	$L_{W,0,A}$ (dB)	$L_{W,0,idle,B}$ (dB)	$L_{W,0,aer,B}$ (dB)	$L_{W,0,B}$ (dB)
50	107.555	80.500	112.600	113.784	84.800	36.700	84.800
63	109.488	81.400	113.200	114.741	86.600	38.500	86.600
80	113.387	80.500	115.700	117.707	83.400	39.000	83.400
100	116.981	82.200	117.400	120.206	81.600	37.500	81.600
125	117.164	80.000	115.300	119.342	80.500	36.800	80.500
160	118.602	79.700	115.000	120.175	80.500	37.100	80.500
200	120.391	79.600	114.900	121.472	79.500	36.400	79.500
250	123.447	96.400	116.400	124.237	94.300	36.200	94.300
315	124.265	80.500	115.900	124.856	78.300	35.900	78.300
400	125.645	81.300	116.300	126.123	78.400	36.300	78.400
500	126.315	97.200	116.200	126.724	94.400	36.300	94.400
630	126.932	79.500	115.200	127.214	77.700	36.300	77.700
800	130.056	79.800	115.800	130.216	77.300	36.200	77.300
1000	131.682	86.700	115.700	131.790	84.600	36.500	84.600
1250	132.521	81.700	115.700	132.611	79.500	36.400	79.500
1600	132.154	82.700	114.700	132.231	81.700	105.200	105.219
2000	133.541	80.700	114.700	133.598	79.800	110.300	110.304
2500	134.405	78.000	115.000	134.455	76.900	110.400	110.402
3150	133.680	75.100	114.500	133.732	74.100	105.600	105.603
4000	129.396	72.100	113.100	129.497	71.300	37.200	71.302
5000	126.484	69.600	112.100	126.639	68.600	37.500	68.603
6300	124.005	66.700	110.600	124.199	66.000	37.900	66.007
8000	122.344	64.100	109.600	122.569	63.500	38.400	63.513
10000	120.984	61.800	108.800	121.239	61.300	39.200	61.327

3.3.5 Test Case 1.5: Determination of the sound power level $L_{W,0,A,f}$ or $L_{W,0,B,f}$ as a function of the type of superstructure - Freight vehicles

For rail vehicles, Table 3.2 applies:

- Number of units of vehicle type t: *1*
- Vehicle type: *Freight vehicles according to Table 3.2 (a)*
- Number of axles per vehicle: *Na = 4 according to Schall 03, Supplement 1, vehicle category 10*
- Brake type: *Block brake, composite block according to Table 3.2 (k)*
- Speed v = 100 km/h
- Measures relating to the wheels: no measure (n)

For track type according to Table 3.3:

- Railhead roughness: average rail condition (normally maintained and smooth) (A)
- Type of rail pad: Medium (250 to 800 MN/m) (M)
- Additional measures: None (N)
- Rail joints: None (N)
- Curvature: Low (R ≥ 500m) (KN)

Superstructure: *Wooden sleepers in ballast bed according to Table 3.3, (H)*

Table 3.3.5-1: Superstructure (H) (Source: Eisenbahnbundesamt [8])

Frequency [Hz]	$L_{W,0,rol,A}$(dB)+ C_{br}+C_{cu}	$L_{W,0,idle,A}$ (dB)	$L_{W,0,aer,A}$ (dB)	$L_{W,0,A}$ (dB)	$L_{W,0,idle,B}$ (dB)	$L_{W,0,aer,B}$ (dB)	$L_{W,0,B}$ (dB)
50	92.571	-	-	92.571	-	-	-
63	94.504	-	-	94.504	-	-	-
80	97.886	-	-	97.886	-	-	-
100	100.565	-	-	100.565	-	-	-
125	99.810	-	-	99.810	-	-	-
160	100.206	-	-	100.206	-	-	-
200	101.130	-	-	101.130	-	-	-
250	104.019	-	-	104.019	-	-	-
315	104.319	-	-	104.319	-	-	-
400	105.183	-	-	105.183	-	-	-
500	105.402	-	-	105.402	-	-	-
630	105.534	-	-	105.534	-	-	-
800	107.416	-	-	107.416	-	-	-
1000	107.727	-	-	107.727	-	-	-
1250	107.008	-	-	107.008	-	-	-
1600	104.810	-	-	104.810	-	-	-
2000	105.264	-	-	105.264	-	-	-
2500	106.241	-	-	106.241	-	-	-
3150	106.548	-	-	106.548	-	-	-
4000	104.308	-	-	104.308	-	-	-
5000	103.238	-	-	103.238	-	-	-
6300	102.267	-	-	102.267	-	-	-
8000	102.765	-	-	102.765	-	-	-
10000	102.914	-	-	102.914	-	-	-

Superstructure: *Solid roadway according to Table 3.3, (S)*

Table 3.3.5-2: Superstructure (S) (Source: Eisenbahnbundesamt [8])

Frequency [Hz]	$L_{W,0,rol,A}$(dB)+ C_{br}+C_{cu}	$L_{W,0,idle,A}$ (dB)	$L_{W,0,aer,A}$ (dB)	$L_{W,0,A}$ (dB)	$L_{W,0,idle,B}$ (dB)	$L_{W,0,aer,B}$ (dB)	$L_{W,0,B}$ (dB)
50	92.575	-	-	92.575	-	-	-
63	94.517	-	-	94.517	-	-	-
80	97.924	-	-	97.924	-	-	-
100	100.738	-	-	100.738	-	-	-
125	100.224	-	-	100.224	-	-	-
160	100.717	-	-	100.717	-	-	-
200	101.727	-	-	101.727	-	-	-
250	104.675	-	-	104.675	-	-	-
315	105.020	-	-	105.020	-	-	-
400	110.730	-	-	110.730	-	-	-
500	111.134	-	-	111.134	-	-	-
630	111.422	-	-	111.422	-	-	-
800	110.979	-	-	110.979	-	-	-
1000	111.332	-	-	111.332	-	-	-
1250	110.356	-	-	110.356	-	-	-
1600	105.566	-	-	105.566	-	-	-
2000	105.804	-	-	105.804	-	-	-
2500	106.560	-	-	106.560	-	-	-
3150	106.757	-	-	106.757	-	-	-
4000	104.561	-	-	104.561	-	-	-
5000	103.491	-	-	103.491	-	-	-
6300	102.516	-	-	102.516	-	-	-
8000	103.014	-	-	103.014	-	-	-
10000	103.163	-	-	103.163	-	-	-

Superstructure: *Concrete bridge, sleeper track in ballast bed according to Table 3.3, (LB)*

Table 3.3.5-3: Superstructure (LB) (Source: Eisenbahnbundesamt [8])

Frequency [Hz]	$L_{W,0,rol,A}$(dB)+ C_{br}+C_{cu}	$L_{W,0,idle,A}$ (dB)	$L_{W,0,aer,A}$ (dB)	$L_{W,0,A}$ (dB)	$L_{W,0,idle,B}$ (dB)	$L_{W,0,aer,B}$ (dB)	$L_{W,0,B}$ (dB)
50	95.571	-	-	95.571	-	-	-
63	97.504	-	-	97.504	-	-	-
80	100.886	-	-	100.886	-	-	-
100	103.565	-	-	103.565	-	-	-
125	102.810	-	-	102.810	-	-	-
160	103.206	-	-	103.206	-	-	-
200	104.130	-	-	104.130	-	-	-
250	107.019	-	-	107.019	-	-	-
315	107.319	-	-	107.319	-	-	-
400	108.183	-	-	108.183	-	-	-
500	108.402	-	-	108.402	-	-	-
630	108.534	-	-	108.534	-	-	-
800	110.416	-	-	110.416	-	-	-
1000	110.727	-	-	110.727	-	-	-
1250	110.008	-	-	110.008	-	-	-
1600	107.810	-	-	107.810	-	-	-
2000	108.264	-	-	108.264	-	-	-
2500	109.241	-	-	109.241	-	-	-
3150	109.548	-	-	109.548	-	-	-
4000	107.308	-	-	107.308	-	-	-
5000	106.238	-	-	106.238	-	-	-
6300	105.267	-	-	105.267	-	-	-
8000	105.765	-	-	105.765	-	-	-
10000	105.914	-	-	105.914	-	-	-

Superstructure: *Steel bridge, sleeper track in ballast bed according to Table 3.3, (LS)*

Table 3.3.5-4: Superstructure (LS) (Source: Eisenbahnbundesamt [8])

Frequency [Hz]	$L_{W,0,rol,A}$(dB)+ C_{br}+C_{cu}	$L_{W,0,idle,A}$ (dB)	$L_{W,0,aer,A}$ (dB)	$L_{W,0,A}$ (dB)	$L_{W,0,idle,B}$ (dB)	$L_{W,0,aer,B}$ (dB)	$L_{W,0,B}$ (dB)
50	98.571	-	-	98.571	-	-	-
63	100.504	-	-	100.504	-	-	-
80	103.886	-	-	103.886	-	-	-
100	106.565	-	-	106.565	-	-	-
125	105.810	-	-	105.810	-	-	-
160	106.206	-	-	106.206	-	-	-
200	107.130	-	-	107.130	-	-	-
250	110.019	-	-	110.019	-	-	-
315	110.319	-	-	110.319	-	-	-
400	111.183	-	-	111.183	-	-	-
500	111.402	-	-	111.402	-	-	-
630	111.534	-	-	111.534	-	-	-
800	113.416	-	-	113.416	-	-	-
1000	113.727	-	-	113.727	-	-	-
1250	113.008	-	-	113.008	-	-	-
1600	110.810	-	-	110.810	-	-	-
2000	111.264	-	-	111.264	-	-	-
2500	112.241	-	-	112.241	-	-	-
3150	112.548	-	-	112.548	-	-	-
4000	110.308	-	-	110.308	-	-	-
5000	109.238	-	-	109.238	-	-	-
6300	108.267	-	-	108.267	-	-	-
8000	108.765	-	-	108.765	-	-	-
10000	108.914	-	-	108.914	-	-	-

3.3.6 Test Case 1.6: Determination of the sound power level $L_{W,0,A,f}$ or $L_{W,0,B,f}$ as a function of railhead roughness - High speed railcar

For rail vehicles, Table 3.2 applies:

- Number of units of vehicle type t: *1*
- Vehicle type: *High speed vehicle according to Table 3.2 (h2)*
- Number of axles per vehicle: *Na = 32 according to Schall 03, Supplement 1, vehicle category 4*
- Brake type: *Wheel disc brake or shaft disc brake according to Table 3.2 (n)*
- Speed v = 300 km/h
- Measures relating to the wheels: no measure (n)

For track type according to Table 3.3:

- Superstructure: Concrete sleepers in ballast bed (B)
- Type of rail pad: Medium (250 to 800 MN/m) (M)
- Additional measures: None (N)
- Rail joints: None (N)
- Curvature: Low (R ≥ 500m) (KN)

Railhead roughness: *Specifically monitored track (büG) according to Table 3.3, (B)*

Table 3.3.6-1: Railhead roughness (B) (Source: Eisenbahnbundesamt [8])

Frequency [Hz]	$L_{W,0,rol,A}$(dB)+ C_{br}+C_{cu}	$L_{W,0,idle,A}$ (dB)	$L_{W,0,aer,A}$ (dB)	$L_{W,0,A}$ (dB)	$L_{W,0,idle,B}$ (dB)	$L_{W,0,aer,B}$ (dB)	$L_{W,0,B}$ (dB)
50	101.555	80.500	112.600	112.931	84.800	36.700	84.800
63	103.488	81.400	113.200	113.643	86.600	38.500	86.600
80	107.387	80.500	115.700	116.299	83.400	39.000	83.400
100	110.981	82.200	117.400	118.293	81.600	37.500	81.600
125	111.164	80.000	115.300	116.718	80.500	36.800	80.500
160	112.602	79.700	115.000	116.976	80.500	37.100	80.500
200	114.391	79.600	114.900	117.664	79.500	36.400	79.500
250	117.447	96.400	116.400	119.985	94.300	36.200	94.300
315	118.265	80.500	115.900	120.252	78.300	35.900	78.300
400	119.645	81.300	116.300	121.298	78.400	36.300	78.400
500	120.315	97.200	116.200	121.753	94.400	36.300	94.400
630	120.932	79.500	115.200	121.961	77.700	36.300	77.700
800	124.056	79.800	115.800	124.661	77.300	36.200	77.300
1000	125.682	86.700	115.700	126.098	84.600	36.500	84.600
1250	125.110	81.700	115.700	125.581	79.500	36.400	79.500
1600	123.813	82.700	114.700	124.316	81.700	105.200	105.219
2000	125.136	80.700	114.700	125.512	79.800	110.300	110.304
2500	125.547	78.000	115.000	125.914	76.900	110.400	110.402
3150	124.365	75.100	114.500	124.791	74.100	105.600	105.603
4000	119.873	72.100	113.100	120.702	71.300	37.200	71.302
5000	116.954	69.600	112.100	118.183	68.600	37.500	68.603
6300	114.623	66.700	110.600	116.072	66.000	37.900	66.007
8000	113.108	64.100	109.600	114.709	63.500	38.400	63.513
10000	112.281	61.800	108.800	113.891	61.300	39.200	61.327

Railhead roughness: *EN ISO 3095: 2013 well maintained and very smooth,*

according to Table 3.3, (T)

Table 3.3.6-2: Railhead roughness (T) (Source: Eisenbahnbundesamt [8])

Frequency [Hz]	$L_{W,0,rol,A}$(dB)+ C_{br}+C_{cu}	$L_{W,0,idle,A}$ (dB)	$L_{W,0,aer,A}$ (dB)	$L_{W,0,A}$ (dB)	$L_{W,0,idle,B}$ (dB)	$L_{W,0,aer,B}$ (dB)	$L_{W,0,B}$ (dB)
50	107.589	80.500	112.600	113.793	84.800	36.700	84.800
63	109.522	81.400	113.200	114.751	86.600	38.500	86.600
80	113.421	80.500	115.700	117.720	83.400	39.000	83.400
100	117.015	82.200	117.400	120.223	81.600	37.500	81.600
125	117.198	80.000	115.300	119.362	80.500	36.800	80.500
160	118.636	79.700	115.000	120.199	80.500	37.100	80.500
200	120.425	79.600	114.900	121.498	79.500	36.400	79.500
250	122.741	96.400	116.400	123.656	94.300	36.200	94.300
315	122.220	80.500	115.900	123.131	78.300	35.900	78.300
400	122.372	81.300	116.300	123.331	78.400	36.300	78.400
500	122.095	97.200	116.200	123.101	94.400	36.300	94.400
630	121.955	79.500	115.200	122.787	77.700	36.300	77.700
800	124.186	79.800	115.800	124.774	77.300	36.200	77.300
1000	125.142	86.700	115.700	125.610	84.600	36.500	84.600
1250	125.413	81.700	115.700	125.854	79.500	36.400	79.500
1600	124.411	82.700	114.700	124.852	81.700	105.200	105.219
2000	125.195	80.700	114.700	125.566	79.800	110.300	110.304
2500	125.505	78.000	115.000	125.875	76.900	110.400	110.402
3150	124.494	75.100	114.500	124.909	74.100	105.600	105.603
4000	120.266	72.100	113.100	121.029	71.300	37.200	71.302
5000	117.603	69.600	112.100	118.680	68.600	37.500	68.603
6300	115.475	66.700	110.600	116.698	66.000	37.900	66.007
8000	114.179	64.100	109.600	115.477	63.500	38.400	63.513
10000	113.154	61.800	108.800	114.512	61.300	39.200	61.327

3.3.7 Test Case 1.7: Determination of the sound power level $L_{W,0,A,f}$ or $L_{W,0,B,f}$ as a function of railhead roughness - Freight vehicles

For rail vehicles, Table 3.2 applies:

- Number of units of vehicle type t: *1*
- Vehicle type: *Freight vehicles according to Table 3.2 (a)*
- Number of axles per vehicle: *Na = 4 according to Schall 03, Supplement 1, vehicle category 10*
- Brake type: *Block brake with composite or sintered metal brake block soles according to Table 3.2, (k)*
- Speed v = 100 km/h
- Measures relating to the wheels: no measure (n)

For track type according to Table 3.3:

- Superstructure: Concrete sleepers in ballast bed (B)
- Type of rail pad: Medium (250 to 800 MN/m) (M)
- Additional measures: None (N)
- Rail joints: None (N)
- Curvature: Low (R ≥ 500m) (KN)

Railhead roughness: *Specifically monitored track (büG) according to Table 3.3, (B)*

Table 3.3.7-1: Railhead roughness (B) (Source: Eisenbahnbundesamt [8])

Frequency [Hz]	$L_{W,0,rol,A}$(dB)+ C_{br}+C_{cu}	$L_{W,0,idle,A}$ (dB)	$L_{W,0,aer,A}$ (dB)	$L_{W,0,A}$ (dB)	$L_{W,0,idle,B}$ (dB)	$L_{W,0,aer,B}$ (dB)	$L_{W,0,B}$ (dB)
50	92.571	-	-	92.571	-	-	-
63	94.504	-	-	94.504	-	-	-
80	97.886	-	-	97.886	-	-	-
100	100.565	-	-	100.565	-	-	-
125	99.810	-	-	99.810	-	-	-
160	100.206	-	-	100.206	-	-	-
200	101.130	-	-	101.130	-	-	-
250	104.019	-	-	104.019	-	-	-
315	104.319	-	-	104.319	-	-	-
400	103.913	-	-	103.913	-	-	-
500	102.329	-	-	102.329	-	-	-
630	102.581	-	-	102.581	-	-	-
800	104.274	-	-	104.274	-	-	-
1000	104.266	-	-	104.266	-	-	-
1250	103.671	-	-	103.671	-	-	-
1600	101.680	-	-	101.680	-	-	-
2000	102.380	-	-	102.380	-	-	-
2500	103.656	-	-	103.656	-	-	-
3150	104.447	-	-	104.447	-	-	-
4000	102.683	-	-	102.683	-	-	-
5000	101.888	-	-	101.888	-	-	-
6300	101.771	-	-	101.771	-	-	-
8000	102.765	-	-	102.765	-	-	-
10000	102.914	-	-	102.914	-	-	-

Railhead roughness: *EN ISO 3095: 2013 (well maintained and very smooth) according to Table 3.3, (T)*

Table 3.3.7-2: Railhead roughness (T) (Source: Eisenbahnbundesamt [8])

Frequency [Hz]	$L_{W,0,rol,A}$(dB)+ C_{br}+C_{cu}	$L_{W,0,idle,A}$ (dB)	$L_{W,0,aer,A}$ (dB)	$L_{W,0,A}$ (dB)	$L_{W,0,idle,B}$ (dB)	$L_{W,0,aer,B}$ (dB)	$L_{W,0,B}$ (dB)
50	98.570	-	-	98.570	-	-	-
63	100.503	-	-	100.503	-	-	-
80	103.355	-	-	103.355	-	-	-
100	105.013	-	-	105.013	-	-	-
125	103.264	-	-	103.264	-	-	-
160	102.554	-	-	102.554	-	-	-
200	102.565	-	-	102.565	-	-	-
250	104.514	-	-	104.514	-	-	-
315	103.844	-	-	103.844	-	-	-
400	103.875	-	-	103.875	-	-	-
500	103.403	-	-	103.403	-	-	-
630	102.873	-	-	102.873	-	-	-
800	104.200	-	-	104.200	-	-	-
1000	104.351	-	-	104.351	-	-	-
1250	103.963	-	-	103.963	-	-	-
1600	102.182	-	-	102.182	-	-	-
2000	103.026	-	-	103.026	-	-	-
2500	104.403	-	-	104.403	-	-	-
3150	105.106	-	-	105.106	-	-	-
4000	103.222	-	-	103.222	-	-	-
5000	102.443	-	-	102.443	-	-	-
6300	101.836	-	-	101.836	-	-	-
8000	102.568	-	-	102.568	-	-	-
10000	102.807	-	-	102.807	-	-	-

3.3.8 Test Case 1.8: Determination of the sound power level $L_{W,0,A,f}$ or $L_{W,0,B,f}$ subject to the type of additional measures - High speed railcar

For rail vehicles, Table 3.2 applies:

- Number of units of vehicle type t: *1*
- Vehicle type: *High speed vehicle according to Table 3.2 (h2)*
- Number of axles per vehicle: *Na = 32 according to Schall 03, Supplement 1, vehicle category 4*
- Brake type: *Wheel disc brake or shaft disc brake according to Table 3.2 (n)*
- Speed v = 300 km/h
- Measures relating to the wheels: no measure (n)

For track type according to Table 3.3:

- Railhead roughness: average rail condition (normally maintained and smooth) (A)
- Type of rail pad: Medium (250 to 800 MN/m) (M)
- Rail joints: None (N)
- Curvature: Low (R ≥ 500m) (KN)

Superstructure: *Concrete sleepers in ballast bed, according to table 3.3, (B)*

Additional measures: *Rail web damper for sleeper track in ballast bed according to Table 3.3, (D1)*

Table 3.3.8-1: Superstructure (B), additional measures (D1) (Source: Eisenbahnbundesamt [8])

Frequency [Hz]	$L_{W,0,rol,A}$(dB)+ C_{br}+C_{cu}	$L_{W,0,idle,A}$ (dB)	$L_{W,0,aer,A}$ (dB)	$L_{W,0,A}$ (dB)	$L_{W,0,idle,B}$ (dB)	$L_{W,0,aer,B}$ (dB)	$L_{W,0,B}$ (dB)
50	101.555	80.500	112.600	112.931	84.800	36.700	84.800
63	103.488	81.400	113.200	113.643	86.600	38.500	86.600
80	107.387	80.500	115.700	116.299	83.400	39.000	83.400
100	110.981	82.200	117.400	118.293	81.600	37.500	81.600
125	111.164	80.000	115.300	116.718	80.500	36.800	80.500
160	112.602	79.700	115.000	116.976	80.500	37.100	80.500
200	114.391	79.600	114.900	117.664	79.500	36.400	79.500
250	117.447	96.400	116.400	119.985	94.300	36.200	94.300
315	118.265	80.500	115.900	120.252	78.300	35.900	78.300
400	118.744	81.300	116.300	120.702	78.400	36.300	78.400
500	119.353	97.200	116.200	121.085	94.400	36.300	94.400
630	119.916	79.500	115.200	121.180	77.700	36.300	77.700
800	121.432	79.800	115.800	122.482	77.300	36.200	77.300
1000	122.995	86.700	115.700	123.738	84.600	36.500	84.600
1250	124.198	81.700	115.700	124.773	79.500	36.400	79.500
1600	124.657	82.700	114.700	125.075	81.700	105.200	105.219
2000	126.554	80.700	114.700	126.829	79.800	110.300	110.304
2500	127.865	78.000	115.000	128.084	76.900	110.400	110.402
3150	127.680	75.100	114.500	127.884	74.100	105.600	105.603
4000	123.396	72.100	113.100	123.784	71.300	37.200	71.302
5000	120.484	69.600	112.100	121.072	68.600	37.500	68.603
6300	118.005	66.700	110.600	118.731	66.000	37.900	66.007
8000	116.344	64.100	109.600	117.178	63.500	38.400	63.513
10000	114.984	61.800	108.800	115.921	61.300	39.200	61.327

Superstructure: *Concrete sleepers in ballast bed according to table 3.3, (B)*

Additional measures: *Rail web damper for sleeper track in ballast bed according to table 3.3, (D2)*

Table 3.3.8-2: Superstructure (B), additional measures (D2) (Source: Eisenbahnbundesamt [8])

Frequency [Hz]	$L_{W,0,rol,A}$(dB)+ C_{br}+C_{cu}	$L_{W,0,idle,A}$ (dB)	$L_{W,0,aer,A}$ (dB)	$L_{W,0,A}$ (dB)	$L_{W,0,idle,B}$ (dB)	$L_{W,0,aer,B}$ (dB)	$L_{W,0,B}$ (dB)
50	101.555	80.500	112.600	112.931	84.800	36.700	84.800
63	103.488	81.400	113.200	113.643	86.600	38.500	86.600
80	107.387	80.500	115.700	116.299	83.400	39.000	83.400
100	110.981	82.200	117.400	118.293	81.600	37.500	81.600
125	111.164	80.000	115.300	116.718	80.500	36.800	80.500
160	112.602	79.700	115.000	116.976	80.500	37.100	80.500
200	114.391	79.600	114.900	117.664	79.500	36.400	79.500
250	117.447	96.400	116.400	119.985	94.300	36.200	94.300
315	118.265	80.500	115.900	120.252	78.300	35.900	78.300
400	119.081	81.300	116.300	120.920	78.400	36.300	78.400
500	119.714	97.200	116.200	121.330	94.400	36.300	94.400
630	120.299	79.500	115.200	121.469	77.700	36.300	77.700
800	123.335	79.800	115.800	124.041	77.300	36.200	77.300
1000	124.947	86.700	115.700	125.436	84.600	36.500	84.600
1250	125.868	81.700	115.700	126.267	79.500	36.400	79.500
1600	125.582	82.700	114.700	125.923	81.700	105.200	105.219
2000	127.151	80.700	114.700	127.391	79.800	110.300	110.304
2500	128.185	78.000	115.000	128.388	76.900	110.400	110.402
3150	127.680	75.100	114.500	127.884	74.100	105.600	105.603
4000	123.396	72.100	113.100	123.784	71.300	37.200	71.302
5000	120.484	69.600	112.100	121.072	68.600	37.500	68.603
6300	118.005	66.700	110.600	118.731	66.000	37.900	66.007
8000	116.344	64.100	109.600	117.178	63.500	38.400	63.513
10000	114.984	61.800	108.800	115.921	61.300	39.200	61.327

Superstructure: *Slab track, according to Table 3.3, (S)*

Additional measures: *Slab track with absorber plate (AS)*

Table 3.3.8-3: Superstructure (S), additional measures (AS) (Source: Eisenbahnbundesamt [8])

Frequency [Hz]	$L_{W,0,rol,A}$(dB)+ C_{br}+C_{cu}	$L_{W,0,idle,A}$ (dB)	$L_{W,0,aer,A}$ (dB)	$L_{W,0,A}$ (dB)	$L_{W,0,idle,B}$ (dB)	$L_{W,0,aer,B}$ (dB)	$L_{W,0,B}$ (dB)
50	101.555	80.500	112.600	112.931	84.800	36.700	84.800
63	103.488	81.400	113.200	113.643	86.600	38.500	86.600
80	107.387	80.500	115.700	116.299	83.400	39.000	83.400
100	110.981	82.200	117.400	118.293	81.600	37.500	81.600
125	111.164	80.000	115.300	116.718	80.500	36.800	80.500
160	112.602	79.700	115.000	116.976	80.500	37.100	80.500
200	114.391	79.600	114.900	117.664	79.500	36.400	79.500
250	117.447	96.400	116.400	119.985	94.300	36.200	94.300
315	118.265	80.500	115.900	120.252	78.300	35.900	78.300
400	122.513	81.300	116.300	123.444	78.400	36.300	78.400
500	123.307	97.200	116.200	124.088	94.400	36.300	94.400
630	124.031	79.500	115.200	124.565	77.700	36.300	77.700
800	124.789	79.800	115.800	125.305	77.300	36.200	77.300
1000	126.427	86.700	115.700	126.780	84.600	36.500	84.600
1250	127.196	81.700	115.700	127.493	79.500	36.400	79.500
1600	124.175	82.700	114.700	124.640	81.700	105.200	105.219
2000	126.262	80.700	114.700	126.555	79.800	110.300	110.304
2500	127.716	78.000	115.000	127.942	76.900	110.400	110.402
3150	127.680	75.100	114.500	127.884	74.100	105.600	105.603
4000	123.396	72.100	113.100	123.784	71.300	37.200	71.302
5000	120.484	69.600	112.100	121.072	68.600	37.500	68.603
6300	118.005	66.700	110.600	118.731	66.000	37.900	66.007
8000	116.344	64.100	109.600	117.178	63.500	38.400	63.513
10000	114.984	61.800	108.800	115.921	61.300	39.200	61.327

3.3.9 Test Case 1.9: Determination of the sound power level $L_{W,0,A,f}$ or $L_{W,0,B,f}$ subject to the type of additional measures - Freight vehicles

For rail vehicles, Table 3.2 applies:

- Number of units of vehicle type t: *1*
- Vehicle type: *Freight vehicles according to Table 3.2 (a)*
- Number of axles per vehicle: *Na = 4 according to Schall 03, Supplement 1, vehicle category 10*
- Brake type: *Block brake, composite block according to Table 3.2 (k)*
- Speed v = 100 km/h
- Measures relating to the wheels: no measure (n)

For track type according to Table 3.3:

- Railhead roughness: average rail condition (normally maintained and smooth) (A)
- Type of rail pad: Medium (250 to 800 MN/m) (M)
- Rail joints: None (N)
- Curvature: Low (R ≥ 500m) (KN)

Superstructure: *Concrete sleepers in ballast bed according to table 3.3, (B)*

Additional measures: *Rail web damper for sleeper track in ballast bed according to Table 3.3, (D1)*

Table 3.3.9-1: Superstructure (B), additional measures (D1) (Source: Eisenbahnbundesamt [8])

Frequency [Hz]	$L_{W,0,rol,A}$(dB)+ C_{br}+C_{cu}	$L_{W,0,idle,A}$ (dB)	$L_{W,0,aer,A}$ (dB)	$L_{W,0,A}$ (dB)	$L_{W,0,idle,B}$ (dB)	$L_{W,0,aer,B}$ (dB)	$L_{W,0,B}$ (dB)
50	92.571	-	-	92.571	-	-	-
63	94.504	-	-	94.504	-	-	-
80	97.886	-	-	97.886	-	-	-
100	100.565	-	-	100.565	-	-	-
125	99.810	-	-	99.810	-	-	-
160	100.206	-	-	100.206	-	-	-
200	101.130	-	-	101.130	-	-	-
250	104.019	-	-	104.019	-	-	-
315	104.319	-	-	104.319	-	-	-
400	104.281	-	-	104.281	-	-	-
500	104.440	-	-	104.440	-	-	-
630	104.518	-	-	104.518	-	-	-
800	104.792	-	-	104.792	-	-	-
1000	105.040	-	-	105.040	-	-	-
1250	104.685	-	-	104.685	-	-	-
1600	103.313	-	-	103.313	-	-	-
2000	104.277	-	-	104.277	-	-	-
2500	105.701	-	-	105.701	-	-	-
3150	106.548	-	-	106.548	-	-	-
4000	104.308	-	-	104.308	-	-	-
5000	103.238	-	-	103.238	-	-	-
6300	102.267	-	-	102.267	-	-	-
8000	102.765	-	-	102.765	-	-	-
10000	102.914	-	-	102.914	-	-	-

Superstructure: *Concrete sleepers in ballast bed according to table 3.3, (B)*

Additional measures: *Rail web damper for sleeper track in ballast bed according to table 3.3, (D2)*

Table 3.3.9-2: Superstructure (B), additional measures (D2) (Source: Eisenbahnbundesamt [8])

Frequency [Hz]	$L_{W,0,rol,A}$(dB)+ C_{br}+C_{cu}	$L_{W,0,idle,A}$ (dB)	$L_{W,0,aer,A}$ (dB)	$L_{W,0,A}$ (dB)	$L_{W,0,idle,B}$ (dB)	$L_{W,0,aer,B}$ (dB)	$L_{W,0,B}$ (dB)
50	92.571	-	-	92.571	-	-	-
63	94.504	-	-	94.504	-	-	-
80	97.886	-	-	97.886	-	-	-
100	100.565	-	-	100.565	-	-	-
125	99.810	-	-	99.810	-	-	-
160	100.206	-	-	100.206	-	-	-
200	101.130	-	-	101.130	-	-	-
250	104.019	-	-	104.019	-	-	-
315	104.319	-	-	104.319	-	-	-
400	104.618	-	-	104.618	-	-	-
500	104.801	-	-	104.801	-	-	-
630	104.901	-	-	104.901	-	-	-
800	106.695	-	-	106.695	-	-	-
1000	106.993	-	-	106.993	-	-	-
1250	106.354	-	-	106.354	-	-	-
1600	104.238	-	-	104.238	-	-	-
2000	104.873	-	-	104.873	-	-	-
2500	106.020	-	-	106.020	-	-	-
3150	106.548	-	-	106.548	-	-	-
4000	104.308	-	-	104.308	-	-	-
5000	103.238	-	-	103.238	-	-	-
6300	102.267	-	-	102.267	-	-	-
8000	102.765	-	-	102.765	-	-	-
10000	102.914	-	-	102.914	-	-	-

Superstructure: *Solid roadway according to Table 3.3, (S)*

Additional measures: *Slab track with absorber plate, (AS)*

Table 3.3.9-3: Superstructure (S), additional measures (AS) (Source: Eisenbahnbundesamt [8])

Frequency [Hz]	$L_{W,0,rol,A}$(dB)+ C_{br}+C_{cu}	$L_{W,0,idle,A}$ (dB)	$L_{W,0,aer,A}$ (dB)	$L_{W,0,A}$ (dB)	$L_{W,0,idle,B}$ (dB)	$L_{W,0,aer,B}$ (dB)	$L_{W,0,B}$ (dB)
50	92.571	-	-	92.571	-	-	-
63	94.504	-	-	94.504	-	-	-
80	97.886	-	-	97.886	-	-	-
100	100.565	-	-	100.565	-	-	-
125	99.810	-	-	99.810	-	-	-
160	100.206	-	-	100.206	-	-	-
200	101.130	-	-	101.130	-	-	-
250	104.019	-	-	104.019	-	-	-
315	104.319	-	-	104.319	-	-	-
400	108.050	-	-	108.050	-	-	-
500	108.394	-	-	108.394	-	-	-
630	108.633	-	-	108.633	-	-	-
800	108.149	-	-	108.149	-	-	-
1000	108.472	-	-	108.472	-	-	-
1250	107.682	-	-	107.682	-	-	-
1600	102.832	-	-	102.832	-	-	-
2000	103.985	-	-	103.985	-	-	-
2500	105.552	-	-	105.552	-	-	-
3150	106.548	-	-	106.548	-	-	-
4000	104.308	-	-	104.308	-	-	-
5000	103.238	-	-	103.238	-	-	-
6300	102.267	-	-	102.267	-	-	-
8000	102.765	-	-	102.765	-	-	-
10000	102.914	-	-	102.914	-	-	-

3.3.10 Test Case 1.10: Determination of the sound power level $L_{W,0,A,f}$ or $L_{W,0,B,f}$ as a function of the curvature - High speed railcar

For rail vehicles, Table 3.2 applies:

- Number of units of vehicle type t: *1*
- Vehicle type: *High speed vehicle according to Table 3.2 (h2)*
- Number of axles per vehicle: *Na = 32 according to Schall 03, Supplement 1, vehicle category 4*
- Brake type: *Wheel disc brake or shaft disc brake according to Table 3.2 (n)*
- Speed v = 70 km/h
- Measures relating to the wheels: no measure (n)

For track type according to Table 3.3:

- Superstructure: Concrete sleepers in ballast bed (B)
- Railhead roughness: average rail condition (normally maintained and smooth) (A)
- Type of rail pad: Medium (250 to 800 MN/m) (M)
- Additional measures: None (N)
- Rail joints: None (N)

Curvature: *Medium (300 m ≤ R < 500m) according to Table 3.3, (KM)*

Table 3.3.10-1: Curvature (KM) (Source: Eisenbahnbundesamt [8])

Frequency [Hz]	$L_{W,0,rol,A}$(dB)+ C_{br}+C_{cu}	$L_{W,0,idle,A}$ (dB)	$L_{W,0,aer,A}$ (dB)	$L_{W,0,A}$ (dB)	$L_{W,0,idle,B}$ (dB)	$L_{W,0,aer,B}$ (dB)	$L_{W,0,B}$ (dB)
50	104.461	80.500	-	104.478	84.800	-	84.800
63	105.489	81.400	-	105.506	86.600	-	86.600
80	109.067	80.500	-	109.073	83.400	-	83.400
100	111.955	82.200	-	111.959	81.600	-	81.600
125	111.321	80.000	-	111.324	80.500	-	80.500
160	111.708	79.700	-	111.711	80.500	-	80.500
200	112.983	79.600	-	112.985	79.500	-	79.500
250	115.568	96.400	-	115.620	94.300	-	94.300
315	115.504	80.500	-	115.505	78.300	-	78.300
400	115.761	81.300	-	115.763	78.400	-	78.400
500	115.472	97.200	-	115.536	94.400	-	94.400
630	114.526	79.500	-	114.527	77.700	-	77.700
800	115.144	79.800	-	115.145	77.300	-	77.300
1000	114.081	86.700	-	114.089	84.600	-	84.600
1250	112.978	81.700	-	112.982	79.500	-	79.500
1600	111.911	82.700	-	111.916	81.700	-	81.700
2000	113.231	80.700	-	113.233	79.800	-	79.800
2500	114.085	78.000	-	114.086	76.900	-	76.900
3150	114.469	75.100	-	114.469	74.100	-	74.100
4000	111.145	72.100	-	111.145	71.300	-	71.300
5000	109.792	69.600	-	109.793	68.600	-	68.600
6300	109.144	66.700	-	109.144	66.000	-	66.000
8000	108.070	64.100	-	108.070	63.500	-	63.500
10000	107.479	61.800	-	107.479	61.300	-	61.300

Curvature: *High (R < 300 m) according to Table 3.3, (KH)*

Table 3.3.10-2: Curvature (KH) (Source: Eisenbahnbundesamt [8])

Frequency [Hz]	$L_{W,0,rol,A}$(dB)+ C_{br}+C_{cu}	$L_{W,0,idle,A}$ (dB)	$L_{W,0,aer,A}$ (dB)	$L_{W,0,A}$ (dB)	$L_{W,0,idle,B}$ (dB)	$L_{W,0,aer,B}$ (dB)	$L_{W,0,B}$ (dB)
50	109.461	80.500	-	109.466	84.800	-	84.800
63	110.489	81.400	-	110.495	86.600	-	86.600
80	114.067	80.500	-	114.069	83.400	-	83.400
100	116.955	82.200	-	116.956	81.600	-	81.600
125	116.321	80.000	-	116.322	80.500	-	80.500
160	116.708	79.700	-	116.709	80.500	-	80.500
200	117.983	79.600	-	117.983	79.500	-	79.500
250	120.568	96.400	-	120.584	94.300	-	94.300
315	120.504	80.500	-	120.504	78.300	-	78.300
400	120.761	81.300	-	120.762	78.400	-	78.400
500	120.472	97.200	-	120.492	94.400	-	94.400
630	119.526	79.500	-	119.526	77.700	-	77.700
800	120.144	79.800	-	120.144	77.300	-	77.300
1000	119.081	86.700	-	119.083	84.600	-	84.600
1250	117.978	81.700	-	117.979	79.500	-	79.500
1600	116.911	82.700	-	116.912	81.700	-	81.700
2000	118.231	80.700	-	118.232	79.800	-	79.800
2500	119.085	78.000	-	119.085	76.900	-	76.900
3150	119.469	75.100	-	119.469	74.100	-	74.100
4000	116.145	72.100	-	116.145	71.300	-	71.300
5000	114.792	69.600	-	114.792	68.600	-	68.600
6300	114.144	66.700	-	114.144	66.000	-	66.000
8000	113.070	64.100	-	113.070	63.500	-	63.500
10000	112.479	61.800	-	112.479	61.300	-	61.300

3.3.11 Test Case 1.11: Determination of the sound power level $L_{W,0,A,f}$ or $L_{W,0,B,f}$ as a function of the curvature - Freight vehicles

For rail vehicles, Table 3.2 applies:

- Number of units of vehicle type t: *1*
- Vehicle type: *Freight vehicles according to Table 3.2 (a)*
- Number of axles per vehicle: *Na = 4 according to Schall 03, Supplement 1, vehicle category 10*
- Brake type: *Block brake with composite or sintered metal brake block soles according to Table 3.2, (k)*
- Speed v = 70 km/h
- Measures relating to the wheels: no measure (n)

For track type according to Table 3.3:

- Superstructure: Concrete sleepers in ballast bed (B)
- Railhead roughness: average rail condition (normally maintained and smooth) (A)
- Type of rail pad: Medium (250 to 800 MN/m) (M)
- Additional measures: None (N)
- Rail joints: None (N)

Curvature: *Medium (300 m ≤ R < 500m) according to Table 3.3, (KM)*

Table 3.3.11-1: Curvature (KM) (Source: Eisenbahnbundesamt [8])

Frequency [Hz]	$L_{W,0,rol,A}$(dB)+ C_{br}+C_{cu}		$L_{W,0,idle,A}$ (dB)	$L_{W,0,aer,A}$ (dB)	$L_{W,0,A}$ (dB)	$L_{W,0,idle,B}$ (dB)	$L_{W,0,aer,B}$ (dB)	$L_{W,0,B}$ (dB)
50	95.479		-	-	95.479	-	-	-
63	96.470		-	-	96.470	-	-	-
80	99.383		-	-	99.383	-	-	-
100	102.031		-	-	102.031	-	-	-
125	101.292		-	-	101.292	-	-	-
160	101.804		-	-	101.804	-	-	-
200	102.682		-	-	102.682	-	-	-
250	105.418		-	-	105.418	-	-	-
315	105.520		-	-	105.520	-	-	-
400	106.082		-	-	106.082	-	-	-
500	106.006		-	-	106.006	-	-	-
630	105.311		-	-	105.311	-	-	-
800	106.378		-	-	106.378	-	-	-
1000	105.747		-	-	105.747	-	-	-
1250	104.807		-	-	104.807	-	-	-
1600	103.770		-	-	103.770	-	-	-
2000	105.146		-	-	105.146	-	-	-
2500	106.387		-	-	106.387	-	-	-
3150	107.072		-	-	107.072	-	-	-
4000	104.691		-	-	104.691	-	-	-
5000	105.208		-	-	105.208	-	-	-
6300	105.349		-	-	105.349	-	-	-
8000	104.434		-	-	104.434	-	-	-
10000	104.194		-	-	104.194	-	-	-

Curvature: *High (R < 300 m) according to Table 3.3, (KH)*

Table 3.3.11-2: Curvature (KH) (Source: Eisenbahnbundesamt [8])

Frequency [Hz]	$L_{W,0,rol,A}$(dB)+ C_{br}+C_{cu}	$L_{W,0,idle,A}$ (dB)	$L_{W,0,aer,A}$ (dB)	$L_{W,0,A}$ (dB)	$L_{W,0,idle,B}$ (dB)	$L_{W,0,aer,B}$ (dB)	$L_{W,0,B}$ (dB)
50	100.479	-	-	100.479	-	-	-
63	101.470	-	-	101.470	-	-	-
80	104.383	-	-	104.383	-	-	-
100	107.031	-	-	107.031	-	-	-
125	106.292	-	-	106.292	-	-	-
160	106.804	-	-	106.804	-	-	-
200	107.682	-	-	107.682	-	-	-
250	110.418	-	-	110.418	-	-	-
315	110.520	-	-	110.520	-	-	-
400	111.082	-	-	111.082	-	-	-
500	111.006	-	-	111.006	-	-	-
630	110.311	-	-	110.311	-	-	-
800	111.378	-	-	111.378	-	-	-
1000	110.747	-	-	110.747	-	-	-
1250	109.807	-	-	109.807	-	-	-
1600	108.770	-	-	108.770	-	-	-
2000	110.146	-	-	110.146	-	-	-
2500	111.387	-	-	111.387	-	-	-
3150	112.072	-	-	112.072	-	-	-
4000	109.691	-	-	109.691	-	-	-
5000	110.208	-	-	110.208	-	-	-
6300	110.349	-	-	110.349	-	-	-
8000	109.434	-	-	109.434	-	-	-
10000	109.194	-	-	109.194	-	-	-

3.4 Test Cases: Sound power levels $L_{W,0,A,f}$ in accordance with equations 3.1 and $L_{W,0,B,f}$ 3.2 and sound power levels per meter $L_{W',eq,line,f}$ in accordance with equation 3.5 for trains

3.4.1 Test Case 2.1: 4 IC Trains per hour

For rail vehicles, Table 3.2 applies:

- Speed v = 200 km/h
- Measures relating to the wheels: no measure (n)

For track type according to Table 3.3:

- Superstructure: Concrete sleepers in ballast bed (B)
- Railhead roughness: average rail condition (normally maintained and smooth) (A)
- Type of rail pad: Medium (250 to 800 MN/m) (M)
- Additional measures: None (N)
- Rail joints: None (N)
- Curvature: Low (R at least 500m) (KN)

Table 3.4.1-1: 4 IC trains per hour (Source: Eisenbahnbundesamt [8])

Number of units of vehicle type t: *1*

Passenger coaches according to Table 3.2 (p)

Number of axles per vehicle: *Na = 4 according to Schall 03, Supplement 1, vehicle category 9*

Brake type: *Wheel disc brake or shaft disc brake according to Table 3.2 (n)*

Frequency [Hz]	$L_{W,0,rol,A}$(dB)+ $C_{br}+C_{cu}$	$L_{W,0,idle,A}$ (dB)	$L_{W,0,aer,A}$ (dB)	$L_{W,0,A}$ (dB)	$L_{W,0,idle,B}$ (dB)	$L_{W,0,aer,B}$ (dB)	$L_{W,0,B}$ (dB)
50	92.524	-	-	92.524	74.200	-	74.200
63	94.457	-	-	94.457	78.000	-	78.000
80	98.356	-	-	98.356	76.500	-	76.500
100	101.950	-	-	101.950	76.000	-	76.000
125	102.133	-	-	102.133	77.300	-	77.300
160	103.048	-	-	103.048	79.600	-	79.600
200	104.246	-	-	104.246	82.900	-	82.900
250	107.539	-	-	107.539	77.700	-	77.700
315	108.054	-	-	108.054	76.400	-	76.400
400	109.101	-	-	109.101	81.800	-	81.800
500	109.792	-	-	109.792	78.800	-	78.800
630	110.566	-	-	110.566	76.800	-	76.800
800	113.050	-	-	113.050	74.700	-	74.700
1000	114.278	-	-	114.278	76.000	-	76.000
1250	114.738	-	-	114.738	71.900	-	71.900
1600	113.893	-	-	113.893	70.100	-	70.100
2000	114.378	-	-	114.378	68.200	-	68.200
2500	114.296	-	-	114.296	66.300	-	66.300
3150	112.855	-	-	112.855	65.500	-	65.500
4000	109.289	-	-	109.289	63.700	-	63.700
5000	107.556	-	-	107.556	62.000	-	62.000
6300	105.515	-	-	105.515	60.400	-	60.400
8000	103.938	-	-	103.938	58.900	-	58.900
10000	102.614	-	-	102.614	57.700	-	57.700

Number of units of vehicle type t: *1*

Electric loco according to Table 3.2 (e)

Number of axles per vehicle: *Na = 4 according to Schall 03, Supplement 1, vehicle category 7*

Brake type: *Wheel disc brake or shaft disc brake according to Table 3.2 (n)*

Frequency [Hz]	$L_{W,0,rol,A}$(dB)+ C_{br}+C_{cu}	$L_{W,0,idle,A}$ (dB)	$L_{W,0,aer,A}$ (dB)	$L_{W,0,A}$ (dB)	$L_{W,0,idle,B}$ (dB)	$L_{W,0,aer,B}$ (dB)	$L_{W,0,B}$ (dB)
50	92.524	87.900	-	93.810	92.200	-	92.200
63	94.457	90.800	-	96.013	96.000	-	96.000
80	98.356	91.600	-	99.188	94.500	-	94.500
100	101.950	94.600	-	102.684	94.000	-	94.000
125	102.011	94.800	-	102.767	95.300	-	95.300
160	102.796	96.800	-	103.770	97.600	-	97.600
200	104.078	104.000	-	107.049	103.900	-	103.900
250	108.796	100.800	-	109.435	98.700	-	98.700
315	108.851	99.600	-	109.339	97.400	-	97.400
400	109.215	101.700	-	109.924	98.800	-	98.800
500	109.769	98.600	-	110.089	95.800	-	95.800
630	110.443	95.600	-	110.583	93.800	-	93.800
800	112.519	95.200	-	112.599	92.700	-	92.700
1000	113.466	96.100	-	113.544	94.000	-	94.000
1250	113.603	92.100	-	113.634	89.900	-	89.900
1600	112.533	89.100	-	112.553	88.100	-	88.100
2000	118.017	87.100	-	118.021	86.200	-	86.200
2500	113.905	85.400	-	113.911	84.300	-	84.300
3150	109.444	83.500	-	109.455	82.500	-	82.500
4000	106.732	81.500	-	106.745	80.700	-	80.700
5000	107.203	80.000	-	107.211	79.000	-	79.000
6300	106.044	78.100	-	106.051	77.400	-	77.400
8000	103.122	76.500	-	103.131	75.900	-	75.900
10000	102.314	75.200	-	102.322	74.700	-	74.700

(Source: Eisenbahnbundesamt [8])

Sound power level per meter (undirected) from all vehicles according to equations 3.4 and 3.5 (without directivity measure)

Number of units of vehicle type t: *48 Passenger coaches according to Table 3.2 (p)*

Number of units of vehicle type t: *4 Electric locos according to Table 3.2 (e)*

Frequency [Hz]	$L_{W',0,rol,A}$(dB)+ C_{br}+C_{cu}	$L_{W',0,idle,A}$ (dB)	$L_{W',0,aer,A}$ (dB)	$L_{W',0,A}$ (dB)	$L_{W',0,idle,B}$ (dB)	$L_{W',0,aer,B}$ (dB)	$L_{W',0,B}$ (dB)
50	56.673	40.910	-	56.787	45.966	-	45.966
63	58.607	43.810	-	58.748	49.766	-	49.766
80	62.506	44.610	-	62.576	48.266	-	48.266
100	66.100	47.610	-	66.161	47.766	-	47.766
125	66.273	47.810	-	66.335	49.066	-	49.066
160	67.179	49.810	-	67.258	51.366	-	51.366
200	68.383	57.010	-	68.689	57.306	-	57.306
250	71.800	53.810	-	71.868	52.106	-	52.106
315	72.271	52.610	-	72.318	50.806	-	50.806
400	73.260	54.710	-	73.320	52.743	-	52.743
500	73.940	51.610	-	73.966	49.743	-	49.743
630	74.706	48.610	-	74.717	47.743	-	47.743
800	77.161	48.210	-	77.167	46.466	-	46.466
1000	78.370	49.110	-	78.376	47.766	-	47.766
1250	78.810	45.110	-	78.812	43.666	-	43.666
1600	77.952	42.110	-	77.953	41.866	-	41.866
2000	78.946	40.110	-	78.946	39.966	-	39.966
2500	78.417	38.410	-	78.418	38.066	-	38.066
3150	76.819	36.510	-	76.820	36.443	-	36.443
4000	73.287	34.510	-	73.288	34.643	-	34.643
5000	71.679	33.010	-	71.680	32.943	-	32.943
6300	69.708	31.110	-	69.709	31.343	-	31.343
8000	68.030	29.510	-	68.031	29.843	-	29.843
10000	66.741	28.210	-	66.742	28.643	-	28.643

(Source: Eisenbahnbundesamt [8])

Sum of all $L_{W,0}$ of all vehicles per hour

Number of units of vehicle type t: *48 Passenger coaches according to Table 3.2 (p)*

Number of units of vehicle type t: *4 Electric locos according to Table 3.2 (e)*

Frequency [Hz]	$L_{W,0,A}$ (dB)	$L_{W,0,B}$ (dB)
50	109.797	98.977
63	111.758	102.777
80	115.586	101.277
100	119.171	100.777
125	119.345	102.077
160	120.268	104.377
200	121.699	110.316
250	124.878	105.116
315	125.328	103.816
400	126.330	105.753
500	126.976	102.753
630	127.727	100.753
800	130.177	99.477
1000	131.386	100.777
1250	131.822	96.677
1600	130.963	94.877
2000	131.956	92.977
2500	131.428	91.077
3150	129.830	89.453
4000	126.298	87.653
5000	124.690	85.953
6300	122.719	84.353
8000	121.041	82.853
10000	119.752	81.653

(Source: Eisenbahnbundesamt [8])

3.4.2 Test Case 2.2: 4 ICE-1 Trains per hour

For rail vehicles, Table 3.2 applies:

- Speed v = 250 km/h
- Measures relating to the wheels: no measure (n)

For track type according to Table 3.3:

- Superstructure: Concrete sleepers in ballast bed (B)
- Railhead roughness: average rail condition (normally maintained and smooth) (A)
- Type of rail pad: Medium (250 to 800 MN/m) (M)
- Additional measures: None (N)
- Rail joints: None (N)
- Curvature: Low (R ≥ 500m) (KN)

Table 3.4.2-1: 4 ICE-1 trains per hour (Source: Eisenbahnbundesamt [8])

Number of units of vehicle type t: *1*

High speed power car according to Table 3.2 (h3)

Number of axles per vehicle: *Na = 4 according to Schall 03, Supplement 1, vehicle category 1*

Brake type: *Wheel disc brake or shaft disc brake according to Table 3.2 (n)*

Frequency [Hz]	$L_{W,0,rol,A}$(dB)+ C_{br}+C_{cu}	$L_{W,0,idle,A}$ (dB)	$L_{W,0,aer,A}$ (dB)	$L_{W,0,A}$ (dB)	$L_{W,0,idle,B}$ (dB)	$L_{W,0,aer,B}$ (dB)	$L_{W,0,B}$ (dB)
50	92.524	87.900	108.641	108.781	92.200	32.741	92.200
63	94.457	90.800	109.241	109.443	96.000	34.541	96.000
80	98.356	91.600	111.741	111.976	94.500	35.041	94.500
100	101.950	94.600	113.441	113.791	94.000	33.541	94.000
125	102.133	94.800	111.341	111.918	95.300	32.841	95.300
160	103.571	96.800	111.041	111.893	97.600	33.141	97.600
200	104.837	104.000	110.941	112.547	103.900	32.441	103.900
250	108.005	100.800	112.441	113.990	98.700	32.241	98.700
315	108.802	99.600	111.941	113.827	97.400	31.941	97.400
400	109.997	101.700	112.341	114.566	98.800	32.341	98.800
500	110.548	98.600	112.241	114.597	95.800	32.341	95.800
630	111.364	95.600	111.241	114.371	93.800	32.341	93.800
800	114.261	95.200	111.841	116.262	92.700	32.241	92.700
1000	115.676	96.100	111.741	117.184	94.000	32.541	94.000
1250	116.303	92.100	111.741	117.618	89.900	32.441	89.900
1600	115.792	89.100	110.741	116.980	88.100	101.241	101.447
2000	116.859	87.100	110.741	117.812	86.200	106.341	106.383
2500	117.246	85.400	111.041	118.181	84.300	106.441	106.467
3150	116.009	83.500	110.541	117.096	82.500	101.641	101.694
4000	111.651	81.500	109.141	113.588	80.700	33.241	80.700
5000	109.429	80.000	108.141	111.846	79.000	33.541	79.000
6300	107.390	78.100	106.641	110.045	77.400	33.941	77.400
8000	105.713	76.500	105.641	108.690	75.900	34.441	75.900
10000	104.538	75.200	104.841	107.705	74.700	35.241	74.700

(Source: Eisenbahnbundesamt [8])

Number of units of vehicle type t: *1*

High speed middle wagon/driving trailer, according to Table 3.2 (h4)

Number of axles per vehicle: *Na = 4 according to Schall 03, Supplement 1, vehicle category 2*

Brake type: *Wheel disc brake or shaft disc brake according to Table 3.2 (n)*

Frequency [Hz]	$L_{W,0,rol,A}$(dB)+ C_{br}+C_{cu}	$L_{W,0,idle,A}$ (dB)	$L_{W,0,aer,A}$ (dB)	$L_{W,0,A}$ (dB)	$L_{W,0,idle,B}$ (dB)	$L_{W,0,aer,B}$ (dB)	$L_{W,0,B}$ (dB)
50	92.524	-	108.641	108.746	74.200	32.741	74.200
63	94.457	-	109.241	109.383	78.000	34.541	78.000
80	98.356	-	111.741	111.936	76.500	35.041	76.500
100	101.950	-	113.441	113.739	76.000	33.541	76.000
125	102.133	-	111.341	111.833	77.300	32.841	77.300
160	103.571	-	111.041	111.756	79.600	33.141	79.600
200	104.837	-	110.941	111.893	82.900	32.441	82.900
250	108.005	-	112.441	113.777	77.700	32.241	77.700
315	108.802	-	111.941	113.659	76.400	31.941	76.400
400	109.997	-	112.341	114.336	81.800	32.341	81.800
500	110.548	-	112.241	114.487	78.800	32.341	78.800
630	111.364	-	111.241	114.313	76.800	32.341	76.800
800	114.261	-	111.841	116.228	74.700	32.241	74.700
1000	115.676	-	111.741	117.150	76.000	32.541	76.000
1250	116.303	-	111.741	117.606	71.900	32.441	71.900
1600	115.792	-	110.741	116.973	70.100	101.241	101.244
2000	116.859	-	110.741	117.809	68.200	106.341	106.342
2500	117.246	-	111.041	118.178	66.300	106.441	106.441
3150	116.009	-	110.541	117.094	65.500	101.641	101.642
4000	111.651	-	109.141	113.585	63.700	33.241	63.704
5000	109.429	-	108.141	111.843	62.000	33.541	62.006
6300	107.390	-	106.641	110.042	60.400	33.941	60.410
8000	105.713	-	105.641	108.688	58.900	34.441	58.916
10000	104.538	-	104.841	107.703	57.700	35.241	57.725

(Source: Eisenbahnbundesamt [8])

Sound power level per meter (undirected) from all vehicles according to equations 3.4 and 3.5 (without directivity measure)

Number of units of vehicle type t: *4 High speed power vehicle according to Table 3.2 (h3)*

Number of units of vehicle type t: *= 48 High speed middle wagon/driving trailer, according to Table 3.2 (h4)*

Frequency [Hz]	$L_{W',0,rol,A}$(dB)+ C_{br}+C_{cu}	$L_{W',0,idle,A}$ (dB)	$L_{W',0,aer,A}$ (dB)	$L_{W',0,A}$ (dB)	$L_{W',0,idle,B}$ (dB)	$L_{W',0,aer,B}$ (dB)	$L_{W',0,B}$ (dB)
50	55.704	39.941	71.822	71.929	44.997	-4.078	44.997
63	57.637	42.841	72.422	72.568	48.797	-2.278	48.797
80	61.537	43.641	74.922	75.119	47.297	-1.778	47.297
100	65.131	46.641	76.622	76.923	46.797	-3.278	46.797
125	65.313	46.841	74.522	75.020	48.097	-3.978	48.097
160	66.752	48.841	74.222	74.948	50.397	-3.678	50.397
200	68.017	56.041	74.122	75.128	56.337	-4.378	56.337
250	71.186	52.841	75.622	76.974	51.137	-4.578	51.137
315	71.982	51.641	75.122	76.853	49.837	-4.878	49.837
400	73.178	53.741	75.522	77.534	51.773	-4.478	51.773
500	73.729	50.641	75.422	77.676	48.773	-4.478	48.773
630	74.545	47.641	74.422	77.498	46.773	-4.478	46.773
800	77.442	47.241	75.022	79.411	45.497	-4.578	45.497
1000	78.856	48.141	74.922	80.333	46.797	-4.278	46.797
1250	79.484	44.141	74.922	80.788	42.697	-4.378	42.697
1600	78.973	41.141	73.922	80.154	40.897	64.422	64.441
2000	80.040	39.141	73.922	80.990	38.997	69.522	69.525
2500	80.426	37.441	74.222	81.359	37.097	69.622	69.624
3150	79.190	35.541	73.722	80.275	35.473	64.822	64.827
4000	74.832	33.541	72.322	76.766	33.673	-3.578	33.674
5000	72.609	32.041	71.322	75.024	31.973	-3.278	31.975
6300	70.571	30.141	69.822	73.223	30.373	-2.878	30.375
8000	68.894	28.541	68.822	71.868	28.873	-2.378	28.877
10000	67.719	27.241	68.022	70.883	27.673	-1.578	27.679

(Source: Eisenbahnbundesamt [8])

Sum of all $L_{W,0}$ of all vehicles per hour

Number of units of vehicle type t: *4 High speed power car according to Table 3.2 (h3)*

Number of units of vehicle type t: *= 48 High speed middle wagon/driving trailer, according to Table 3.2 (h4)*

Frequency [Hz]	$L_{W,0,A}$ (dB)	$L_{W,0,B}$ (dB)
50	125.909	98.977
63	126.548	102.777
80	129.099	101.277
100	130.903	100.777
125	129.000	102.077
160	128.927	104.377
200	129.107	110.316
250	130.953	105.116
315	130.832	103.816
400	131.514	105.753
500	131.655	102.753
630	131.478	100.753
800	133.390	99.477
1000	134.312	100.777
1250	134.767	96.677
1600	134.134	118.420
2000	134.969	123.505
2500	135.339	123.603
3150	134.255	118.806
4000	130.746	87.654
5000	129.003	85.954
6300	127.202	84.355
8000	125.848	82.856
10000	124.863	81.658

(Source: Eisenbahnbundesamt [8])

3.4.3 Test Case 2.3: 4 ICE-3 Trains per hour

For rail vehicles, Table 3.2 applies:

- Speed v = 300 km/h
- Measures relating to the wheels: no measure (n)

For roadways according to Table 3.3:

- Superstructure: *Slab track (S)*
- Railhead roughness: *Specifically monitored track (büG) (B)*
- Type of rail pad: *Medium (250 to 800 MN/m) (M)*
- Additional measures: *Slab track with absorber plate (AS)*
- Rail joints: *None (N)*
- Curvature: *Low (R ≥ 500m) (KN)*

Table 3.4.3-1: 4 ICE-3 trains per hour (Source: Eisenbahnbundesamt [8])

Number of units of vehicle type t: *1*

High speed vehicle according to Table 3.2 (h2)

Number of axles per vehicle: Na = 32 according to Schall 03, Supplement 1, vehicle category 4

Brake type: Wheel disc brake or shaft disc brake according to Table 3.2 (n)

Frequency [Hz]	$L_{W,0,rol,A}$(dB)+ C_{br}+C_{cu}	$L_{W,0,idle,A}$ (dB)	$L_{W,0,aer,A}$ (dB)	$L_{W,0,A}$ (dB)	$L_{W,0,idle,B}$ (dB)	$L_{W,0,aer,B}$ (dB)	$L_{W,0,B}$ (dB)
50	101.555	80.500	112.600	112.931	84.800	36.700	84.800
63	103.488	81.400	113.200	113.643	86.600	38.500	86.600
80	107.387	80.500	115.700	116.299	83.400	39.000	83.400
100	110.981	82.200	117.400	118.293	81.600	37.500	81.600
125	111.164	80.000	115.300	116.718	80.500	36.800	80.500
160	112.602	79.700	115.000	116.976	80.500	37.100	80.500
200	114.391	79.600	114.900	117.664	79.500	36.400	79.500
250	117.447	96.400	116.400	119.985	94.300	36.200	94.300
315	118.265	80.500	115.900	120.252	78.300	35.900	78.300
400	122.513	81.300	116.300	123.444	78.400	36.300	78.400
500	123.307	97.200	116.200	124.088	94.400	36.300	94.400
630	124.031	79.500	115.200	124.565	77.700	36.300	77.700
800	124.789	79.800	115.800	125.305	77.300	36.200	77.300
1000	126.427	86.700	115.700	126.780	84.600	36.500	84.600
1250	125.784	81.700	115.700	126.191	79.500	36.400	79.500
1600	121.834	82.700	114.700	122.603	81.700	105.200	105.219
2000	123.856	80.700	114.700	124.354	79.800	110.300	110.304
2500	124.857	78.000	115.000	125.284	76.900	110.400	110.402
3150	124.365	75.100	114.500	124.791	74.100	105.600	105.603
4000	119.873	72.100	113.100	120.702	71.300	37.200	71.302
5000	116.954	69.600	112.100	118.183	68.600	37.500	68.603
6300	114.623	66.700	110.600	116.072	66.000	37.900	66.007
8000	113.108	64.100	109.600	114.709	63.500	38.400	63.513
10000	112.281	61.800	108.800	113.891	61.300	39.200	61.327

Sound power level per meter (undirected) from all vehicles according to equations 3.4 and 3.5 (without directivity measure)

Number of units of vehicle type t: *4 High speed vehicle according to Table 3.2 (h2)*

Frequency [Hz]	$L_{W',0,rol,A}$(dB)+ C_{br}+C_{cu}	$L_{W',0,idle,A}$ (dB)	$L_{W',0,aer,A}$ (dB)	$L_{W',0,A}$ (dB)	$L_{W',0,idle,B}$ (dB)	$L_{W',0,aer,B}$ (dB)	$L_{W',0,B}$ (dB)
50	52.804	31.749	63.849	64.181	36.049	-12.051	36.049
63	54.737	32.649	64.449	64.893	37.849	-10.251	37.849
80	58.637	31.749	66.949	67.548	34.649	-9.751	34.650
100	62.230	33.449	68.649	69.543	32.849	-11.251	32.850
125	62.413	31.249	66.549	67.967	31.749	-11.951	31.750
160	63.852	30.949	66.249	68.225	31.749	-11.651	31.750
200	65.640	30.849	66.149	68.913	30.749	-12.351	30.750
250	68.697	47.649	67.649	71.234	45.549	-12.551	45.549
315	69.514	31.749	67.149	71.502	29.549	-12.851	29.550
400	73.762	32.549	67.549	74.694	29.649	-12.451	29.650
500	74.556	48.449	67.449	75.338	45.649	-12.451	45.649
630	75.280	30.749	66.449	75.815	28.949	-12.451	28.950
800	76.038	31.049	67.049	76.555	28.549	-12.551	28.550
1000	77.676	37.949	66.949	78.029	35.849	-12.251	35.849
1250	77.034	32.949	66.949	77.440	30.749	-12.351	30.750
1600	73.084	33.949	65.949	73.852	32.949	56.449	56.469
2000	75.106	31.949	65.949	75.604	31.049	61.549	61.553
2500	76.107	29.249	66.249	76.534	28.149	61.649	61.651
3150	75.614	26.349	65.749	76.041	25.349	56.849	56.852
4000	71.123	23.349	64.349	71.951	22.549	-11.551	22.551
5000	68.203	20.849	63.349	69.432	19.849	-11.251	19.853
6300	65.873	17.949	61.849	67.322	17.249	-10.851	17.256
8000	64.357	15.349	60.849	65.958	14.749	-10.351	14.763
10000	63.531	13.049	60.049	65.140	12.549	-9.551	12.576

(Source: Eisenbahnbundesamt [8])

Sum of all $L_{W,0}$ of all vehicles per hour

Number of units of vehicle type t: *4 High speed vehicle according to Table 3.2 (h2)*

Frequency [Hz]	$L_{W,0,A}$ (dB)	$L_{W,0,B}$ (dB)
50	118.952	90.821
63	119.664	92.621
80	122.319	89.421
100	124.314	87.621
125	122.739	86.521
160	122.996	86.521
200	123.684	85.521
250	126.005	100.321
315	126.273	84.321
400	129.465	84.421
500	130.109	100.421
630	130.586	83.721
800	131.326	83.321
1000	132.800	90.621
1250	132.211	85.521
1600	128.623	111.240
2000	130.375	116.324
2500	131.305	116.423
3150	130.812	111.624
4000	126.723	77.322
5000	124.203	74.624
6300	122.093	72.027
8000	120.730	69.534
10000	119.911	67.347

(Source: Eisenbahnbundesamt [8])

3.4.4 Test Case 2.4: 8 Local trains per hour

For rail vehicles, Table 3.2 applies:

- Speed v = 140 km/h
- Measures relating to the wheels: no measure (n)

For track type according to Table 3.3:

- Superstructure: Concrete bridge, tracks directly supported (NB)
- Railhead roughness: average rail condition (normally maintained and smooth) (A)
- Type of rail pad: Medium (250 to 800 MN/m) (M)
- Additional measures: None (N)
- Rail joints: None (N)
- Curvature: Low (R ≥ 500m) (KN)

Table 3.4.4-1: 8 local trains per hour (Source: Eisenbahnbundesamt [8])

Number of units of vehicle type t: *1*

Passenger coaches according to Table 3.2 (p)

Number of axles per vehicle: *Na = 4 according to Schall 03, Supplement 1, vehicle category 9*

Brake type: *Wheel disc brake or shaft disc brake according to Table 3.2 (n)*

Frequency [Hz]	$L_{W,0,rol,A}$(dB)+ C_{br}+C_{cu}	$L_{W,0,idle,A}$ (dB)	$L_{W,0,aer,A}$ (dB)	$L_{W,0,A}$ (dB)	$L_{W,0,idle,B}$ (dB)	$L_{W,0,aer,B}$ (dB)	$L_{W,0,B}$ (dB)
50	96.524	-	-	96.524	74.200	-	74.200
63	98.457	-	-	98.457	78.000	-	78.000
80	102.356	-	-	102.356	76.500	-	76.500
100	105.856	-	-	105.856	76.000	-	76.000
125	105.143	-	-	105.143	77.300	-	77.300
160	106.251	-	-	106.251	79.600	-	79.600
200	107.334	-	-	107.334	82.900	-	82.900
250	110.276	-	-	110.276	77.700	-	77.700
315	110.540	-	-	110.540	76.400	-	76.400
400	111.999	-	-	111.999	81.800	-	81.800
500	112.272	-	-	112.272	78.800	-	78.800
630	112.514	-	-	112.514	76.800	-	76.800
800	114.645	-	-	114.645	74.700	-	74.700
1000	115.534	-	-	115.534	76.000	-	76.000
1250	115.141	-	-	115.141	71.900	-	71.900
1600	113.355	-	-	113.355	70.100	-	70.100
2000	112.922	-	-	112.922	68.200	-	68.200
2500	112.748	-	-	112.748	66.300	-	66.300
3150	112.432	-	-	112.432	65.500	-	65.500
4000	109.742	-	-	109.742	63.700	-	63.700
5000	108.187	-	-	108.187	62.000	-	62.000
6300	106.546	-	-	106.546	60.400	-	60.400
8000	104.191	-	-	104.191	58.900	-	58.900
10000	103.048	-	-	103.048	57.700	-	57.700

Number of units of vehicle type t: *1*

Diesel loco according to Table 3.2 (d)

Number of axles per vehicle: *Na = 4 according to Schall 03, Supplement 1, vehicle category 8*

Brake type: *Wheel disc brake or shaft disc brake according to Table 3.2 (n)*

Frequency [Hz]	$L_{W,0,rol,A}$(dB)+ C_{br}+C_{cu}	$L_{W,0,idle,A}$ (dB)	$L_{W,0,aer,A}$ (dB)	$L_{W,0,A}$ (dB)	$L_{W,0,idle,B}$ (dB)	$L_{W,0,aer,B}$ (dB)	$L_{W,0,B}$ (dB)
50	96.524	99.400	-	101.206	103.700	-	103.700
63	98.457	107.300	-	107.833	112.500	-	112.500
80	102.356	103.100	-	105.754	106.000	-	106.000
100	105.856	102.100	-	107.383	101.500	-	101.500
125	105.021	99.300	-	106.052	99.800	-	99.800
160	105.999	99.300	-	106.841	100.100	-	100.100
200	107.166	99.500	-	107.852	99.400	-	99.400
250	111.533	101.300	-	111.926	99.200	-	99.200
315	111.337	101.100	-	111.730	98.900	-	98.900
400	112.079	102.200	-	112.504	99.300	-	99.300
500	111.834	102.100	-	112.272	99.300	-	99.300
630	111.947	101.100	-	112.290	99.300	-	99.300
800	113.451	101.700	-	113.732	99.200	-	99.200
1000	113.603	101.600	-	113.868	99.500	-	99.500
1250	113.103	99.300	-	113.280	97.100	-	97.100
1600	111.300	96.000	-	111.426	95.000	-	95.000
2000	115.069	93.700	-	115.101	92.800	-	92.800
2500	111.082	101.900	-	111.577	100.800	-	100.800
3150	110.134	89.500	-	110.172	88.500	-	88.500
4000	110.895	87.100	-	110.913	86.300	-	86.300
5000	107.365	90.500	-	107.453	89.500	-	89.500
6300	105.796	81.400	-	105.812	80.700	-	80.700
8000	104.619	81.200	-	104.639	80.600	-	80.600
10000	102.618	79.600	-	102.640	79.100	-	79.100

(Source: Eisenbahnbundesamt [8])

Sound power level per meter (undirected) from all vehicles according to equations 3.4 and 3.5 (without directivity measure)

Number of units of vehicle type t: *40 Passenger coaches according to Table 3.2 (p)*

Number of units of vehicle type t: *8 Diesel loco according to Table 3.2 (d)*

Frequency [Hz]	$L_{W',0,rol,A}$(dB)+ C_{br}+C_{cu}	$L_{W',0,idle,A}$ (dB)	$L_{W',0,aer,A}$ (dB)	$L_{W',0,A}$ (dB)	$L_{W',0,idle,B}$ (dB)	$L_{W',0,aer,B}$ (dB)	$L_{W',0,B}$ (dB)
50	61.875	56.970	-	63.091	61.294	-	61.294
63	63.808	64.870	-	67.381	70.077	-	70.077
80	67.708	60.670	-	68.491	63.594	-	63.594
100	71.207	59.670	-	71.502	59.130	-	59.130
125	70.474	56.870	-	70.659	57.490	-	57.490
160	71.561	56.870	-	71.706	57.859	-	57.859
200	72.657	57.070	-	72.776	57.430	-	57.430
250	75.864	58.870	-	75.949	56.921	-	56.921
315	76.035	58.670	-	76.114	56.590	-	56.590
400	77.364	59.770	-	77.439	57.240	-	57.240
500	77.553	59.670	-	77.623	57.059	-	57.059
630	77.776	58.670	-	77.829	56.990	-	56.990
800	79.818	59.270	-	79.856	56.846	-	56.846
1000	80.617	59.170	-	80.648	57.166	-	57.166
1250	80.212	56.870	-	80.232	54.735	-	54.735
1600	78.424	53.570	-	78.438	52.639	-	52.639
2000	78.713	51.270	-	78.721	50.444	-	50.444
2500	77.862	59.470	-	77.924	58.377	-	58.377
3150	77.475	47.070	-	77.479	46.177	-	46.177
4000	75.308	44.670	-	75.311	43.987	-	43.987
5000	73.411	48.070	-	73.424	47.108	-	47.108
6300	71.781	38.970	-	71.783	38.468	-	38.468
8000	69.617	38.770	-	69.620	38.314	-	38.314
10000	68.330	37.170	-	68.333	36.824	-	36.824

(Source: Eisenbahnbundesamt [8])

Sum of all $L_{W,0}$ of all vehicles per hour

Number of units of vehicle type t: *40 Passenger coaches according to Table 3.2 (p)*

Number of units of vehicle type t: *8 Diesel loco according to Table 3.2 (d)*

Frequency [Hz]	$L_{W,0,A}$ (dB)	$L_{W,0,B}$ (dB)
50	114.552	112.755
63	118.843	121.539
80	119.953	115.055
100	122.963	110.592
125	122.120	108.951
160	123.167	109.320
200	124.237	108.892
250	127.411	108.382
315	127.575	108.051
400	128.900	108.701
500	129.085	108.520
630	129.290	108.451
800	131.318	108.307
1000	132.109	108.627
1250	131.694	106.196
1600	129.899	104.101
2000	130.182	101.906
2500	129.386	109.839
3150	128.941	97.638
4000	126.773	95.449
5000	124.885	98.569
6300	123.245	89.929
8000	121.081	89.775
10000	119.795	88.285

(Source: Eisenbahnbundesamt [8])

3.4.5 Test Case 2.5: 2 Diesel railcars/h

For rail vehicles, Table 3.2 applies:

- Speed v = 100 km/h
- Measures relating to the wheels: no measure (n)

For track type according to Table 3.3:

- Superstructure: Concrete sleepers in ballast bed (B)
- Railhead roughness: average rail condition (normally maintained and smooth) (A)
- Type of rail pad: Medium (250 to 800 MN/m) (M)
- Additional measures: None (N)
- Rail joints: None (N)
- Curvature: Medium (300 m ≤ R < 500 m) (KM)

Table 3.4.5-1: 2 diesel railcars/h (Source: Eisenbahnbundesamt [8])

Number of units of vehicle type t: *1*

Diesel power car according to Table 3.2 (l)

Number of axles per vehicle: *Na = 6 according to Schall 03, Supplement 1, vehicle category 6*

Brake type: *Wheel disc brake or shaft disc brake according to Table 3.2 (n)*

Frequency [Hz]	$L_{W,0,rol,A}$(dB)+ C_{br}+C_{cu}	$L_{W,0,idle,A}$ (dB)	$L_{W,0,aer,A}$ (dB)	$L_{W,0,A}$ (dB)	$L_{W,0,idle,B}$ (dB)	$L_{W,0,aer,B}$ (dB)	$L_{W,0,B}$ (dB)
50	97.285	82.600	-	97.430	86.900	-	86.900
63	99.218	82.500	-	99.309	87.700	-	87.700
80	102.594	89.300	-	102.793	92.200	-	92.200
100	105.597	90.300	-	105.723	89.700	-	89.700
125	105.253	93.500	-	105.533	94.000	-	94.000
160	105.769	99.500	-	106.689	100.300	-	100.300
200	106.566	98.700	-	107.223	98.600	-	98.600
250	109.442	95.500	-	109.614	93.400	-	93.400
315	110.214	90.300	-	110.258	88.100	-	88.100
400	111.564	91.400	-	111.606	88.500	-	88.500
500	111.807	91.300	-	111.845	88.500	-	88.500
630	111.443	90.300	-	111.477	88.500	-	88.500
800	113.021	90.900	-	113.048	88.400	-	88.400
1000	113.045	91.800	-	113.078	89.700	-	89.700
1250	111.754	92.800	-	111.809	90.600	-	90.600
1600	108.941	92.800	-	109.046	91.800	-	91.800
2000	108.371	90.800	-	108.446	89.900	-	89.900
2500	107.868	88.100	-	107.913	87.000	-	87.000
3150	107.516	85.200	-	107.542	84.200	-	84.200
4000	106.707	83.200	-	106.727	82.400	-	82.400
5000	105.009	81.700	-	105.029	80.700	-	80.700
6300	102.398	78.800	-	102.417	78.100	-	78.100
8000	101.725	76.200	-	101.737	75.600	-	75.600
10000	101.696	73.900	-	101.703	73.400	-	73.400

Sound power level per meter (undirected) from all vehicles according to equations 3.4 and 3.5 (without directivity measure)

Number of units of vehicle type t: *2 Diesel power car according to Table 3.2 (l)*

Frequency [Hz]	$L_{W',0,rol,A}$(dB)+ C_{br}+C_{cu}	$L_{W',0,idle,A}$ (dB)	$L_{W',0,aer,A}$ (dB)	$L_{W',0,A}$ (dB)	$L_{W',0,idle,B}$ (dB)	$L_{W',0,aer,B}$ (dB)	$L_{W',0,B}$ (dB)
50	50.295	35.610	-	50.440	39.910	-	39.910
63	52.228	35.510	-	52.320	40.710	-	40.710
80	55.604	42.310	-	55.803	45.210	-	45.210
100	58.607	43.310	-	58.734	42.710	-	42.710
125	58.263	46.510	-	58.544	47.010	-	47.010
160	58.779	52.510	-	59.700	53.310	-	53.310
200	59.576	51.710	-	60.234	51.610	-	51.610
250	62.452	48.510	-	62.624	46.410	-	46.410
315	63.224	43.310	-	63.268	41.110	-	41.110
400	64.574	44.410	-	64.616	41.510	-	41.510
500	64.817	44.310	-	64.855	41.510	-	41.510
630	64.454	43.310	-	64.487	41.510	-	41.510
800	66.031	43.910	-	66.058	41.410	-	41.410
1000	66.055	44.810	-	66.088	42.710	-	42.710
1250	64.764	45.810	-	64.819	43.610	-	43.610
1600	61.951	45.810	-	62.056	44.810	-	44.810
2000	61.381	43.810	-	61.457	42.910	-	42.910
2500	60.878	41.110	-	60.924	40.010	-	40.010
3150	60.527	38.210	-	60.552	37.210	-	37.210
4000	59.718	36.210	-	59.737	35.410	-	35.410
5000	58.019	34.710	-	58.039	33.710	-	33.710
6300	55.408	31.810	-	55.427	31.110	-	31.110
8000	54.735	29.210	-	54.747	28.610	-	28.610
10000	54.706	26.910	-	54.714	26.410	-	26.410

(Source: Eisenbahnbundesamt [8])

Sum of all $L_{W,0}$ of all vehicles per hour

Number of units of vehicle type t: *2 Diesel power car according to Table 3.2 (l)*

Frequency [Hz]	$L_{W,0,A}$ (dB)	$L_{W,0,B}$ (dB)
50	100.440	89.910
63	102.320	90.710
80	105.803	95.210
100	108.734	92.710
125	108.544	97.010
160	109.700	103.310
200	110.234	101.610
250	112.624	96.410
315	113.268	91.110
400	114.616	91.510
500	114.855	91.510
630	114.487	91.510
800	116.058	91.410
1000	116.088	92.710
1250	114.819	93.610
1600	112.056	94.810
2000	111.457	92.910
2500	110.924	90.010
3150	110.552	87.210
4000	109.737	85.410
5000	108.039	83.710
6300	105.427	81.110
8000	104.747	78.610
10000	104.714	76.410

(Source: Eisenbahnbundesamt [8])

3.4.6 Test Case 2.6: 2 Freight cars/h

For rail vehicles, Table 3.2 applies:

- Speed v = 80 km/h
- Measures relating to the wheels: no measure (n)

For track type according to Table 3.3:

- Superstructure: Concrete sleepers in ballast bed (B)
- Railhead roughness: average rail condition (normally maintained and smooth) (A)
- Type of rail pad: Medium (250 to 800 MN/m) (M)
- Additional measures: None (N)
- Rail joints: None (N)
- Curvature: Low (R ≥ 500m) (KN)

Table 3.4.6-1: 2 Freight cars/h (Source: Eisenbahnbundesamt [8])

Number of units of vehicle type t: *1*

Diesel loco according to Table 3.2 (d)

Number of axles per vehicle: *Na = 4 according to Schall 03, Supplement 1, vehicle category 8*

Brake type: *Block brake, cast iron block according to Table 3.2 (c)*

Frequency [Hz]	$L_{W,0,rol,A}$(dB)+ C_{br}+C_{cu}	$L_{W,0,idle,A}$ (dB)	$L_{W,0,aer,A}$ (dB)	$L_{W,0,A}$ (dB)	$L_{W,0,idle,B}$ (dB)	$L_{W,0,aer,B}$ (dB)	$L_{W,0,B}$ (dB)
50	92.974	99.400	-	100.291	103.700	-	103.700
63	94.496	107.300	-	107.522	112.500	-	112.500
80	97.522	103.100	-	104.161	106.000	-	106.000
100	100.300	102.100	-	104.303	101.500	-	101.500
125	99.592	99.300	-	102.459	99.800	-	99.800
160	99.918	99.300	-	102.631	100.100	-	100.100
200	101.142	99.500	-	103.408	99.400	-	99.400
250	106.535	101.300	-	107.673	99.200	-	99.200
315	108.319	101.100	-	109.073	98.900	-	98.900
400	110.673	102.200	-	111.250	99.300	-	99.300
500	111.625	102.100	-	112.084	99.300	-	99.300
630	111.231	101.100	-	111.634	99.300	-	99.300
800	111.544	101.700	-	111.972	99.200	-	99.200
1000	109.630	101.600	-	110.265	99.500	-	99.500
1250	106.429	99.300	-	107.198	97.100	-	97.100
1600	104.292	96.000	-	104.893	95.000	-	95.000
2000	112.216	93.700	-	112.277	92.800	-	92.800
2500	110.580	101.900	-	111.132	100.800	-	100.800
3150	107.292	89.500	-	107.364	88.500	-	88.500
4000	106.148	87.100	-	106.202	86.300	-	86.300
5000	105.816	90.500	-	105.942	89.500	-	89.500
6300	104.323	81.400	-	104.345	80.700	-	80.700
8000	103.150	81.200	-	103.178	80.600	-	80.600
10000	103.931	79.600	-	103.947	79.100	-	79.100

Number of units of vehicle type t: *1*

Freight vehicles according to Table 3.2 (a)

Number of axles per vehicle: *Na = 4 according to Schall 03, Supplement 1, vehicle category 10*

Brake type: *Block brake, cast iron block according to Table 3.2 (c)*

Frequency [Hz]	$L_{W,0,rol,A}$(dB)+ C_{br}+C_{cu}	$L_{W,0,idle,A}$ (dB)	$L_{W,0,aer,A}$ (dB)	$L_{W,0,A}$ (dB)	$L_{W,0,idle,B}$ (dB)	$L_{W,0,aer,B}$ (dB)	$L_{W,0,B}$ (dB)
50	92.974	-	-	92.974	-	-	-
63	94.496	-	-	94.496	-	-	-
80	97.522	-	-	97.522	-	-	-
100	100.300	-	-	100.300	-	-	-
125	99.713	-	-	99.713	-	-	-
160	100.170	-	-	100.170	-	-	-
200	101.310	-	-	101.310	-	-	-
250	105.495	-	-	105.495	-	-	-
315	108.038	-	-	108.038	-	-	-
400	111.446	-	-	111.446	-	-	-
500	113.094	-	-	113.094	-	-	-
630	113.211	-	-	113.211	-	-	-
800	113.997	-	-	113.997	-	-	-
1000	112.616	-	-	112.616	-	-	-
1250	110.190	-	-	110.190	-	-	-
1600	107.476	-	-	107.476	-	-	-
2000	107.802	-	-	107.802	-	-	-
2500	108.609	-	-	108.609	-	-	-
3150	108.733	-	-	108.733	-	-	-
4000	106.395	-	-	106.395	-	-	-
5000	105.706	-	-	105.706	-	-	-
6300	105.209	-	-	105.209	-	-	-
8000	105.115	-	-	105.115	-	-	-
10000	106.202	-	-	106.202	-	-	-

(Source: Eisenbahnbundesamt [8])

Sound power level per meter (undirected) from all vehicles according to equations 3.4 and 3.5 (without directivity measure)

Number of units of vehicle type t: *2 diesel loco according to Table 3.2 (d)*

Number of units of vehicle type t: *16 Freight vehicles according to Table 3.2 (a)*

Frequency [Hz]	$L_{W',0,rol,A}$(dB)+ C_{br}+C_{cu}	$L_{W',0,idle,A}$ (dB)	$L_{W',0,aer,A}$ (dB)	$L_{W',0,A}$ (dB)	$L_{W',0,idle,B}$ (dB)	$L_{W',0,aer,B}$ (dB)	$L_{W',0,B}$ (dB)
50	56.496	53.379	-	58.222	57.679	-	57.679
63	58.018	61.279	-	62.958	66.479	-	66.479
80	61.043	57.079	-	62.509	59.979	-	59.979
100	63.822	56.079	-	64.497	55.479	-	55.479
125	63.222	53.279	-	63.641	53.779	-	53.779
160	63.664	53.279	-	64.045	54.079	-	54.079
200	64.813	53.479	-	65.122	53.379	-	53.379
250	69.145	55.279	-	69.320	53.179	-	53.179
315	71.592	55.079	-	71.688	52.879	-	52.879
400	74.889	56.179	-	74.947	53.279	-	53.279
500	76.475	56.079	-	76.514	53.279	-	53.279
630	76.552	55.079	-	76.583	53.279	-	53.279
800	77.305	55.679	-	77.335	53.179	-	53.179
1000	75.891	55.579	-	75.932	53.479	-	53.479
1250	73.423	53.279	-	73.465	51.079	-	51.079
1600	70.740	49.979	-	70.776	48.979	-	48.979
2000	72.101	47.679	-	72.116	46.779	-	46.779
2500	72.400	55.879	-	72.495	54.779	-	54.779
3150	72.117	43.479	-	72.123	42.479	-	42.479
4000	69.890	41.079	-	69.896	40.279	-	40.279
5000	69.240	44.479	-	69.254	43.479	-	43.479
6300	68.640	35.379	-	68.643	34.679	-	34.679
8000	68.458	35.179	-	68.460	34.579	-	34.579
10000	69.522	33.579	-	69.524	33.079	-	33.079

(Source: Eisenbahnbundesamt [8])

Sum of all $L_{W,0}$ of all vehicles per hour

Number of units of vehicle type t: *2 diesel loco according to Table 3.2 (d)*

Number of units of vehicle type t: *16 Freight vehicles according to Table 3.2 (a)*

Frequency [Hz]	$L_{W,0,A}$ (dB)	$L_{W,0,B}$ (dB)
50	107.252	106.710
63	111.989	115.510
80	111.540	109.010
100	113.528	104.510
125	112.672	102.810
160	113.076	103.110
200	114.153	102.410
250	118.351	102.210
315	120.719	101.910
400	123.978	102.310
500	125.545	102.310
630	125.614	102.310
800	126.366	102.210
1000	124.962	102.510
1250	122.496	100.110
1600	119.807	98.010
2000	121.147	95.810
2500	121.526	103.810
3150	121.154	91.510
4000	118.927	89.310
5000	118.285	92.510
6300	117.673	83.710
8000	117.491	83.610
10000	118.554	82.110

(Source: Eisenbahnbundesamt [8])

3.4.7 Test Case 2.7: 4 Freight cars/h

For rail vehicles, Table 3.2 applies:

- Speed v = 100 km/h
- Measures relating to the wheels: no measure (n)

For track type according to Table 3.3:

- Superstructure: *Slab track (S)*
- Railhead roughness: *Specifically monitored track (büG) (B)*
- Type of rail pad: *Medium (250 to 800 MN/m) (M)*
- Additional measures: *None (N)*
- Rail joints: *None (N)*
- Curvature: *Low (R ≥ 500m) (KN)*

Table 3.4.7-1: 4 Freight cars/h (Source: Eisenbahnbundesamt [8])

Number of units of vehicle type t: *1*

Electric loco according to Table 3.2 (e)

Number of axles per vehicle: *Na = 4 according to Schall 03, Supplement 1, vehicle category 7*

Brake type: *Wheel disc brake or shaft disc brake according to Table 3.2 (n)*

Frequency [Hz]	$L_{W,0,rol,A}$(dB)+ C_{br}+C_{cu}	$L_{W,0,idle,A}$ (dB)	$L_{W,0,aer,A}$ (dB)	$L_{W,0,A}$ (dB)	$L_{W,0,idle,B}$ (dB)	$L_{W,0,aer,B}$ (dB)	$L_{W,0,B}$ (dB)
50	92.528	87.900	-	93.813	92.200	-	92.200
63	94.469	90.800	-	96.021	96.000	-	96.000
80	97.871	91.600	-	98.791	94.500	-	94.500
100	101.009	94.600	-	101.903	94.000	-	94.000
125	100.857	94.800	-	101.819	95.300	-	95.300
160	101.449	96.800	-	102.729	97.600	-	97.600
200	102.504	104.000	-	106.326	103.900	-	103.900
250	106.814	100.800	-	107.784	98.700	-	98.700
315	106.735	99.600	-	107.503	97.400	-	97.400
400	110.382	101.700	-	110.933	98.800	-	98.800
500	108.887	98.600	-	109.276	95.800	-	95.800
630	108.291	95.600	-	108.518	93.800	-	93.800
800	106.649	95.200	-	106.950	92.700	-	92.700
1000	105.826	96.100	-	106.265	94.000	-	94.000
1250	103.860	92.100	-	104.141	89.900	-	89.900
1600	98.151	89.100	-	98.660	88.100	-	88.100
2000	103.721	87.100	-	103.815	86.200	-	86.200
2500	103.459	85.400	-	103.527	84.300	-	84.300
3150	102.607	83.500	-	102.660	82.500	-	82.500
4000	99.923	81.500	-	99.985	80.700	-	80.700
5000	99.078	80.000	-	99.131	79.000	-	79.000
6300	98.160	78.100	-	98.203	77.400	-	77.400
8000	97.267	76.500	-	97.303	75.900	-	75.900
10000	96.088	75.200	-	96.124	74.700	-	74.700

Number of units of vehicle type t: *1*

Freight vehicles according to Table 3.2 (a)

Number of axles per vehicle: *Na = 4 according to Schall 03, Supplement 1, vehicle category 10*

Brake type: *Block brake, composite block according to Table 3.2 (k)*

Frequency [Hz]	$L_{W,0,rol,A}$(dB)+ C_{br}+C_{cu}	$L_{W,0,idle,A}$ (dB)	$L_{W,0,aer,A}$ (dB)	$L_{W,0,A}$ (dB)	$L_{W,0,idle,B}$ (dB)	$L_{W,0,aer,B}$ (dB)	$L_{W,0,B}$ (dB)
50	92.575	-	-	92.575	-	-	-
63	94.517	-	-	94.517	-	-	-
80	97.924	-	-	97.924	-	-	-
100	100.738	-	-	100.738	-	-	-
125	100.224	-	-	100.224	-	-	-
160	100.717	-	-	100.717	-	-	-
200	101.727	-	-	101.727	-	-	-
250	104.675	-	-	104.675	-	-	-
315	105.020	-	-	105.020	-	-	-
400	109.461	-	-	109.461	-	-	-
500	108.061	-	-	108.061	-	-	-
630	108.470	-	-	108.470	-	-	-
800	107.837	-	-	107.837	-	-	-
1000	107.871	-	-	107.871	-	-	-
1250	107.019	-	-	107.019	-	-	-
1600	102.435	-	-	102.435	-	-	-
2000	102.920	-	-	102.920	-	-	-
2500	103.975	-	-	103.975	-	-	-
3150	104.655	-	-	104.655	-	-	-
4000	102.937	-	-	102.937	-	-	-
5000	102.141	-	-	102.141	-	-	-
6300	102.020	-	-	102.020	-	-	-
8000	103.014	-	-	103.014	-	-	-
10000	103.163	-	-	103.163	-	-	-

(Source: Eisenbahnbundesamt [8])

Sound power level per meter (undirected) from all vehicles according to equations 3.4 and 3.5 (without directivity measure)

Number of units of vehicle type t: *4 Electric locos according to Table 3.2 (e)*

Number of units of vehicle type t: *80 Freight vehicles according to Table 3.2 (a)*

Frequency [Hz]	$L_{W',0,rol,A}$(dB)+ C_{br}+C_{cu}	$L_{W',0,idle,A}$ (dB)	$L_{W',0,aer,A}$ (dB)	$L_{W',0,A}$ (dB)	$L_{W',0,idle,B}$ (dB)	$L_{W',0,aer,B}$ (dB)	$L_{W',0,B}$ (dB)
50	61.816	43.921	-	61.886	48.221	-	48.221
63	63.757	46.821	-	63.844	52.021	-	52.021
80	67.164	47.621	-	67.212	50.521	-	50.521
100	69.994	50.621	-	70.044	50.021	-	50.021
125	69.500	50.821	-	69.558	51.321	-	51.321
160	69.998	52.821	-	70.080	53.621	-	53.621
200	71.010	60.021	-	71.342	59.921	-	59.921
250	74.047	56.821	-	74.129	54.721	-	54.721
315	74.362	55.621	-	74.420	53.421	-	53.421
400	78.752	57.721	-	78.786	54.821	-	54.821
500	77.347	54.621	-	77.370	51.821	-	51.821
630	77.704	51.621	-	77.715	49.821	-	49.821
800	77.030	51.221	-	77.042	48.721	-	48.721
1000	77.036	52.121	-	77.050	50.021	-	50.021
1250	76.154	48.121	-	76.161	45.921	-	45.921
1600	71.546	45.121	-	71.556	44.121	-	44.121
2000	72.204	43.121	-	72.210	42.221	-	42.221
2500	73.195	41.421	-	73.198	40.321	-	40.321
3150	73.820	39.521	-	73.821	38.521	-	38.521
4000	72.075	37.521	-	72.076	36.721	-	36.721
5000	71.278	36.021	-	71.280	35.021	-	35.021
6300	71.139	34.121	-	71.140	33.421	-	33.421
8000	72.102	32.521	-	72.103	31.921	-	31.921
10000	72.236	31.221	-	72.237	30.721	-	30.721

(Source: Eisenbahnbundesamt [8])

Sum of all $L_{W,0}$ of all vehicles per hour

Number of units of vehicle type t: *4 Electric locos according to Table 3.2 (e)*

Number of units of vehicle type t: *80 Freight vehicles according to Table 3.2 (a)*

Frequency [Hz]	$L_{W,0,A}$ (dB)	$L_{W,0,B}$ (dB)
50	111.886	98.221
63	113.844	102.021
80	117.212	100.521
100	120.044	100.021
125	119.558	101.321
160	120.080	103.621
200	121.342	109.921
250	124.129	104.721
315	124.420	103.421
400	128.786	104.821
500	127.370	101.821
630	127.715	99.821
800	127.042	98.721
1000	127.050	100.021
1250	126.161	95.921
1600	121.556	94.121
2000	122.210	92.221
2500	123.198	90.321
3150	123.821	88.521
4000	122.076	86.721
5000	121.280	85.021
6300	121.140	83.421
8000	122.103	81.921
10000	122.237	80.721

(Source: Eisenbahnbundesamt [8])

3.4.8 Test Case 2.8: 2 Freight cars/h

For rail vehicles, Table 3.2 applies:

- Speed v = 120 km/h
- Measures relating to the wheels: no measure (n)

For track type according to Table 3.3:

- Superstructure: Steel bridge, sleeper track in ballast bed (LS)
- Railhead roughness: Average rail condition (normally maintained and smooth) (A)
- Type of rail pad: Medium (250 to 800 MN/m) (M)
- Additional measures: None (N)
- Rail joints: None (N)
- Curvature: Low (R ≥ 500m) (KN)

Table 3.4.8-1: 2 freight cars/h (Source: Eisenbahnbundesamt [8])

Number of units of vehicle type t: *1*

Electric loco according to Table 3.2 (e)

Number of axles per vehicle: *Na = 4 according to Schall 03, Supplement 1, vehicle category 7*

Brake type: *Wheel disc brake or shaft disc brake according to Table 3.2 (n)*

Frequency [Hz]	$L_{W,0,rol,A}$(dB)+ C_{br}+C_{cu}	$L_{W,0,idle,A}$ (dB)	$L_{W,0,aer,A}$ (dB)	$L_{W,0,A}$ (dB)	$L_{W,0,idle,B}$ (dB)	$L_{W,0,aer,B}$ (dB)	$L_{W,0,B}$ (dB)
50	98.524	87.900	-	98.885	92.200	-	92.200
63	100.457	90.800	-	100.903	96.000	-	96.000
80	104.356	91.600	-	104.581	94.500	-	94.500
100	107.247	94.600	-	107.477	94.000	-	94.000
125	106.848	94.800	-	107.111	95.300	-	95.300
160	107.526	96.800	-	107.879	97.600	-	97.600
200	108.622	104.000	-	109.909	103.900	-	103.900
250	112.875	100.800	-	113.136	98.700	-	98.700
315	113.040	99.600	-	113.233	97.400	-	97.400
400	113.027	101.700	-	113.336	98.800	-	98.800
500	112.872	98.600	-	113.032	95.800	-	95.800
630	112.651	95.600	-	112.736	93.800	-	93.800
800	113.809	95.200	-	113.868	92.700	-	92.700
1000	113.852	96.100	-	113.924	94.000	-	94.000
1250	113.180	92.100	-	113.213	89.900	-	89.900
1600	110.365	89.100	-	110.397	88.100	-	88.100
2000	114.672	87.100	-	114.680	86.200	-	86.200
2500	112.347	85.400	-	112.356	84.300	-	84.300
3150	112.890	83.500	-	112.895	82.500	-	82.500
4000	110.241	81.500	-	110.247	80.700	-	80.700
5000	108.321	80.000	-	108.327	79.000	-	79.000
6300	106.891	78.100	-	106.896	77.400	-	77.400
8000	104.804	76.500	-	104.810	75.900	-	75.900
10000	103.406	75.200	-	103.412	74.700	-	74.700

Number of units of vehicle type t: *1*

Freight vehicles according to Table 3.2 (a)

Number of axles per vehicle: *Na = 4 according to Schall 03, Supplement 1, vehicle category 10*

Brake type: *Wheel disc brake or shaft disc brake according to Table 3.2 (n)*

Frequency [Hz]	$L_{W,0,rol,A}$(dB)+ C_{br}+C_{cu}	$L_{W,0,idle,A}$ (dB)	$L_{W,0,aer,A}$ (dB)	$L_{W,0,A}$ (dB)	$L_{W,0,idle,B}$ (dB)	$L_{W,0,aer,B}$ (dB)	$L_{W,0,B}$ (dB)
50	98.524	-	-	98.524	-	-	-
63	100.457	-	-	100.457	-	-	-
80	104.356	-	-	104.356	-	-	-
100	107.247	-	-	107.247	-	-	-
125	106.970	-	-	106.970	-	-	-
160	107.778	-	-	107.778	-	-	-
200	108.790	-	-	108.790	-	-	-
250	111.618	-	-	111.618	-	-	-
315	112.244	-	-	112.244	-	-	-
400	113.211	-	-	113.211	-	-	-
500	113.430	-	-	113.430	-	-	-
630	113.512	-	-	113.512	-	-	-
800	115.513	-	-	115.513	-	-	-
1000	116.000	-	-	116.000	-	-	-
1250	115.419	-	-	115.419	-	-	-
1600	113.091	-	-	113.091	-	-	-
2000	112.818	-	-	112.818	-	-	-
2500	113.299	-	-	113.299	-	-	-
3150	113.156	-	-	113.156	-	-	-
4000	110.347	-	-	110.347	-	-	-
5000	109.143	-	-	109.143	-	-	-
6300	106.888	-	-	106.888	-	-	-
8000	104.879	-	-	104.879	-	-	-
10000	104.673	-	-	104.673	-	-	-

(Source: Eisenbahnbundesamt [8])

Sound power level per meter (undirected) from all vehicles according to equations 3.4 and 3.5 (without directivity measure)

Number of units of vehicle type t: *2 Electric locos according to Table 3.2 (e)*

Number of units of vehicle type t: *50 Freight vehicles according to Table 3.2 (a)*

Frequency [Hz]	$L_{W',0,rol,A}$(dB)+ C_{br}+C_{cu}	$L_{W',0,idle,A}$ (dB)	$L_{W',0,aer,A}$ (dB)	$L_{W',0,A}$ (dB)	$L_{W',0,idle,B}$ (dB)	$L_{W',0,aer,B}$ (dB)	$L_{W',0,B}$ (dB)
50	64.892	40.118	-	64.906	44.418	-	44.418
63	66.825	43.018	-	66.843	48.218	-	48.218
80	70.725	43.818	-	70.733	46.718	-	46.718
100	73.616	46.818	-	73.625	46.218	-	46.218
125	73.333	47.018	-	73.343	47.518	-	47.518
160	74.137	49.018	-	74.150	49.818	-	49.818
200	75.152	56.218	-	75.207	56.118	-	56.118
250	78.042	53.018	-	78.056	50.918	-	50.918
315	78.646	51.818	-	78.655	49.618	-	49.618
400	79.572	53.918	-	79.584	51.018	-	51.018
500	79.778	50.818	-	79.783	48.018	-	48.018
630	79.851	47.818	-	79.853	46.018	-	46.018
800	81.827	47.418	-	81.828	44.918	-	44.918
1000	82.303	48.318	-	82.304	46.218	-	46.218
1250	81.720	44.318	-	81.720	42.118	-	42.118
1600	79.381	41.318	-	79.382	40.318	-	40.318
2000	79.274	39.318	-	79.275	38.418	-	38.418
2500	79.635	37.618	-	79.635	36.518	-	36.518
3150	79.514	35.718	-	79.514	34.718	-	34.718
4000	76.711	33.718	-	76.711	32.918	-	32.918
5000	75.482	32.218	-	75.482	31.218	-	31.218
6300	73.256	30.318	-	73.257	29.618	-	29.618
8000	71.244	28.718	-	71.244	28.118	-	28.118
10000	70.999	27.418	-	70.999	26.918	-	26.918

(Source: Eisenbahnbundesamt [8])

Sum of all $L_{W,0}$ of all vehicles per hour

Number of units of vehicle type t: *2 Electric locos according to Table 3.2 (e)*

Number of units of vehicle type t: *50 Freight vehicles according to Table 3.2 (a)*

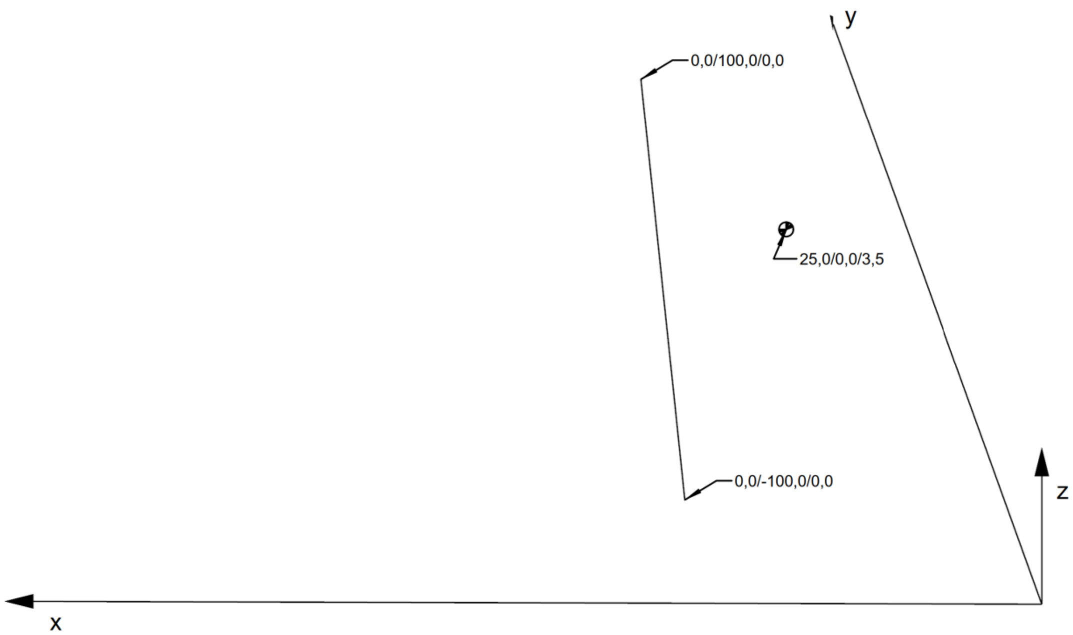
Frequency [Hz]	$L_{W,0,A}$ (dB)	$L_{W,0,B}$ (dB)
50	115.698	95.210
63	117.635	99.010
80	121.525	97.510
100	124.416	97.010
125	124.135	98.310
160	124.942	100.610
200	125.999	106.910
250	128.848	101.710
315	129.446	100.410
400	130.376	101.810
500	130.575	98.810
630	130.645	96.810
800	132.620	95.710
1000	133.096	97.010
1250	132.512	92.910
1600	130.173	91.110
2000	130.067	89.210
2500	130.427	87.310
3150	130.306	85.510
4000	127.503	83.710
5000	126.274	82.010
6300	124.048	80.410
8000	122.036	78.910
10000	121.791	77.710

(Source: Eisenbahnbundesamt [8])

3.5 Test Cases: Directional effect $L_{W,0,dir,f}$ according to equation 3.7

3.5.1 Test Case 3.1: Horizontal directivity for a straight section of track

Figure 3.5.1-1: Horizontal directivity (Source: Eisenbahnbundesamt [8])



For rail vehicles, Table 3.2 applies:

- Number of units of vehicle type t: *1*
- Vehicle type: *High speed vehicle according to Table 3.2 (h2)*
- Number of axles per vehicle: *Na = 32 according to Schall 03, Supplement 1, vehicle category 4*
- Speed: *300 km/h*
- Brake type: *Wheel disc brake or shaft disc brake according to Table 3.2 (n)*
- Measures relating to the wheels: no measure (n)

For track type according to Table 3.3:

- Superstructure: Concrete sleepers in ballast bed (B)
- Railhead roughness: average rail condition (normally maintained and smooth) (A)
- Type of rail pad: Medium (250 to 800 MN/m) (M)
- Additional measures: None (N)
- Rail joints: None (N)
- Curvature: Low (R ≥ 500m) (KN)

Table 3.5.1-1: Coordinates of ground level, track axis and point of immission (Source: Eisenbahnbundesamt [8])

	x	y	z
Ground elevation			0
Start of track axis	0.0	-100.0	0.0
End of track axis	0.0	100.0	0.0
Point of immission	25.0	0.0	3.5

Table 3.5.1-2: Geometry data for source height A: 0.5m (according to eq. 3.8 and eq. 3.9.) (Source: Eisenbahnbundesamt [8])

(Table is continued on next page)

Segment coordinates															(
x (m)	y (m)	z (m)	phi (°)	$L_{W,dir,hor,A}$ (d	Psi (°)	50 Hz	63 Hz	80 Hz	100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz
0	-100	0,0	14,036	-11,660	1,667	0,066	0,067	0,069	0,070	0,072	0,075	0,078	0,081	0,085	0,090
0	-95	0,0	14,744	-11,301	1,749	0,069	0,070	0,072	0,074	0,076	0,079	0,082	0,085	0,089	0,095
0	-90	0,0	15,524	-10,920	1,840	0,073	0,074	0,076	0,077	0,080	0,083	0,086	0,089	0,094	0,100
0	-85	0,0	16,390	-10,515	1,939	0,077	0,078	0,080	0,082	0,084	0,087	0,090	0,094	0,099	0,105
0	-80	0,0	17,354	-10,084	2,050	0,081	0,083	0,084	0,086	0,089	0,092	0,095	0,100	0,105	0,111
0	-75	0,0	18,435	-9,626	2,173	0,086	0,087	0,089	0,091	0,094	0,097	0,101	0,106	0,111	0,117
0	-70	0,0	19,654	-9,137	2,311	0,091	0,093	0,095	0,097	0,100	0,104	0,108	0,112	0,118	0,125
0	-65	0,0	21,038	-8,615	2,467	0,098	0,099	0,101	0,104	0,107	0,110	0,115	0,120	0,126	0,133
0	-60	0,0	22,620	-8,056	2,643	0,104	0,106	0,108	0,111	0,114	0,118	0,123	0,128	0,135	0,143
0	-55	0,0	24,444	-7,459	2,843	0,112	0,114	0,117	0,119	0,123	0,127	0,132	0,138	0,145	0,153
0	-50	0,0	26,565	-6,819	3,072	0,121	0,123	0,126	0,129	0,132	0,137	0,143	0,149	0,156	0,166
0	-45	0,0	29,055	-6,135	3,335	0,131	0,134	0,136	0,140	0,144	0,149	0,155	0,161	0,170	0,180
0	-40	0,0	32,005	-5,405	3,639	0,143	0,146	0,149	0,152	0,157	0,162	0,168	0,176	0,185	0,196
0	-35	0,0	35,538	-4,629	3,990	0,157	0,159	0,163	0,167	0,171	0,178	0,184	0,192	0,202	0,214
0	-30	0,0	39,806	-3,812	4,393	0,172	0,175	0,179	0,183	0,188	0,195	0,203	0,211	0,222	0,235
0	-25	0,0	45,000	-2,967	4,850	0,190	0,193	0,197	0,202	0,207	0,215	0,223	0,233	0,245	0,259
0	-20	0,0	51,340	-2,121	5,353	0,209	0,212	0,217	0,222	0,228	0,236	0,245	0,256	0,269	0,285
0	-15	0,0	59,036	-1,320	5,875	0,228	0,232	0,237	0,242	0,249	0,258	0,268	0,280	0,294	0,311
0	-10	0,0	68,199	-0,638	6,358	0,246	0,250	0,255	0,261	0,268	0,278	0,289	0,302	0,317	0,336
0	-5	0,0	78,690	-0,169	6,711	0,259	0,263	0,268	0,275	0,283	0,293	0,304	0,317	0,334	0,353
0	0	0,0	90,000	0,000	6,843	0,263	0,268	0,273	0,280	0,288	0,298	0,310	0,323	0,340	0,360
0	5	0,0	101,310	-0,169	6,711	0,259	0,263	0,268	0,275	0,283	0,293	0,304	0,317	0,334	0,353
0	10	0,0	111,801	-0,638	6,358	0,246	0,250	0,255	0,261	0,268	0,278	0,289	0,302	0,317	0,336
0	15	0,0	120,964	-1,320	5,875	0,228	0,232	0,237	0,242	0,249	0,258	0,268	0,280	0,294	0,311
0	20	0,0	128,660	-2,121	5,353	0,209	0,212	0,217	0,222	0,228	0,236	0,245	0,256	0,269	0,285
0	25	0,0	135,000	-2,967	4,850	0,190	0,193	0,197	0,202	0,207	0,215	0,223	0,233	0,245	0,259
0	30	0,0	140,194	-3,812	4,393	0,172	0,175	0,179	0,183	0,188	0,195	0,203	0,211	0,222	0,235
0	35	0,0	144,462	-4,629	3,990	0,157	0,159	0,163	0,167	0,171	0,178	0,184	0,192	0,202	0,214
0	40	0,0	147,995	-5,405	3,639	0,143	0,146	0,149	0,152	0,157	0,162	0,168	0,176	0,185	0,196
0	45	0,0	150,945	-6,135	3,335	0,131	0,134	0,136	0,140	0,144	0,149	0,155	0,161	0,170	0,180
0	50	0,0	153,435	-6,819	3,072	0,121	0,123	0,126	0,129	0,132	0,137	0,143	0,149	0,156	0,166
0	55	0,0	155,556	-7,459	2,843	0,112	0,114	0,117	0,119	0,123	0,127	0,132	0,138	0,145	0,153
0	60	0,0	157,380	-8,056	2,643	0,104	0,106	0,108	0,111	0,114	0,118	0,123	0,128	0,135	0,143
0	65	0,0	158,962	-8,615	2,467	0,098	0,099	0,101	0,104	0,107	0,110	0,115	0,120	0,126	0,133
0	70	0,0	160,346	-9,137	2,311	0,091	0,093	0,095	0,097	0,100	0,104	0,108	0,112	0,118	0,125
0	75	0,0	161,565	-9,626	2,173	0,086	0,087	0,089	0,091	0,094	0,097	0,101	0,106	0,111	0,117
0	80	0,0	162,646	-10,084	2,050	0,081	0,083	0,084	0,086	0,089	0,092	0,095	0,100	0,105	0,111
0	85	0,0	163,610	-10,515	1,939	0,077	0,078	0,080	0,082	0,084	0,087	0,090	0,094	0,099	0,105
0	90	0,0	164,476	-10,920	1,840	0,073	0,074	0,076	0,077	0,080	0,083	0,086	0,089	0,094	0,100
0	95	0,0	165,256	-11,301	1,749	0,069	0,070	0,072	0,074	0,076	0,079	0,082	0,085	0,089	0,095
0	100	0,0	165,964	-11,660	1,667	0,066	0,067	0,069	0,070	0,072	0,075	0,078	0,081	0,085	0,090

Geometry													
$\Delta L_{W,dir,vert,A,f}$													
500 Hz	630 Hz	800 Hz	1000 Hz	1250 Hz	1600 Hz	2000 Hz	2500 Hz	3150 Hz	4000 Hz	5000 Hz	6300 Hz	8000 Hz	10000 Hz
0,096	0,102	0,109	0,117	0,125	0,134	0,144	0,154	0,164	0,176	0,187	0,199	0,211	0,223
0,100	0,107	0,114	0,122	0,131	0,141	0,151	0,161	0,172	0,184	0,196	0,208	0,221	0,233
0,105	0,112	0,120	0,129	0,138	0,148	0,159	0,169	0,181	0,194	0,206	0,219	0,233	0,245
0,111	0,118	0,127	0,136	0,145	0,156	0,167	0,179	0,191	0,204	0,217	0,231	0,245	0,259
0,117	0,125	0,134	0,143	0,153	0,165	0,177	0,189	0,202	0,216	0,229	0,244	0,259	0,273
0,124	0,133	0,142	0,152	0,162	0,175	0,187	0,200	0,214	0,229	0,243	0,258	0,275	0,290
0,132	0,141	0,151	0,161	0,173	0,186	0,199	0,213	0,227	0,243	0,259	0,275	0,292	0,308
0,141	0,150	0,161	0,172	0,184	0,198	0,212	0,227	0,243	0,260	0,276	0,293	0,311	0,329
0,151	0,161	0,172	0,184	0,197	0,212	0,227	0,243	0,260	0,278	0,295	0,314	0,333	0,352
0,162	0,173	0,185	0,198	0,212	0,228	0,244	0,261	0,279	0,299	0,317	0,337	0,358	0,378
0,175	0,187	0,200	0,214	0,229	0,247	0,264	0,282	0,301	0,322	0,343	0,364	0,387	0,408
0,190	0,203	0,217	0,232	0,248	0,267	0,286	0,306	0,327	0,350	0,372	0,395	0,420	0,443
0,207	0,221	0,236	0,253	0,270	0,291	0,312	0,333	0,356	0,381	0,405	0,430	0,457	0,482
0,227	0,242	0,259	0,277	0,296	0,319	0,341	0,365	0,390	0,417	0,443	0,471	0,500	0,528
0,249	0,265	0,284	0,304	0,325	0,350	0,375	0,400	0,428	0,458	0,487	0,517	0,550	0,580
0,274	0,292	0,313	0,334	0,358	0,386	0,413	0,441	0,472	0,504	0,536	0,570	0,605	0,639
0,302	0,321	0,344	0,368	0,394	0,424	0,454	0,485	0,519	0,555	0,590	0,627	0,665	0,702
0,330	0,351	0,376	0,402	0,430	0,464	0,496	0,530	0,567	0,606	0,645	0,685	0,727	0,768
0,355	0,379	0,406	0,434	0,464	0,500	0,535	0,571	0,611	0,654	0,695	0,738	0,784	0,828
0,374	0,399	0,427	0,456	0,488	0,526	0,563	0,601	0,643	0,688	0,731	0,777	0,825	0,871
0,381	0,406	0,435	0,465	0,497	0,536	0,573	0,612	0,655	0,701	0,744	0,791	0,840	0,887
0,374	0,399	0,427	0,456	0,488	0,526	0,563	0,601	0,643	0,688	0,731	0,777	0,825	0,871
0,355	0,379	0,406	0,434	0,464	0,500	0,535	0,571	0,611	0,654	0,695	0,738	0,784	0,828
0,330	0,351	0,376	0,402	0,430	0,464	0,496	0,530	0,567	0,606	0,645	0,685	0,727	0,768
0,302	0,321	0,344	0,368	0,394	0,424	0,454	0,485	0,519	0,555	0,590	0,627	0,665	0,702
0,274	0,292	0,313	0,334	0,358	0,386	0,413	0,441	0,472	0,504	0,536	0,570	0,605	0,639
0,249	0,265	0,284	0,304	0,325	0,350	0,375	0,400	0,428	0,458	0,487	0,517	0,550	0,580
0,227	0,242	0,259	0,277	0,296	0,319	0,341	0,365	0,390	0,417	0,443	0,471	0,500	0,528
0,207	0,221	0,236	0,253	0,270	0,291	0,312	0,333	0,356	0,381	0,405	0,430	0,457	0,482
0,190	0,203	0,217	0,232	0,248	0,267	0,286	0,306	0,327	0,350	0,372	0,395	0,420	0,443
0,175	0,187	0,200	0,214	0,229	0,247	0,264	0,282	0,301	0,322	0,343	0,364	0,387	0,408
0,162	0,173	0,185	0,198	0,212	0,228	0,244	0,261	0,279	0,299	0,317	0,337	0,358	0,378
0,151	0,161	0,172	0,184	0,197	0,212	0,227	0,243	0,260	0,278	0,295	0,314	0,333	0,352
0,141	0,150	0,161	0,172	0,184	0,198	0,212	0,227	0,243	0,260	0,276	0,293	0,311	0,329
0,132	0,141	0,151	0,161	0,173	0,186	0,199	0,213	0,227	0,243	0,259	0,275	0,292	0,308
0,124	0,133	0,142	0,152	0,162	0,175	0,187	0,200	0,214	0,229	0,243	0,258	0,275	0,290
0,117	0,125	0,134	0,143	0,153	0,165	0,177	0,189	0,202	0,216	0,229	0,244	0,259	0,273
0,111	0,118	0,127	0,136	0,145	0,156	0,167	0,179	0,191	0,204	0,217	0,231	0,245	0,259
0,105	0,112	0,120	0,129	0,138	0,148	0,159	0,169	0,181	0,194	0,206	0,219	0,233	0,245
0,100	0,107	0,114	0,122	0,131	0,141	0,151	0,161	0,172	0,184	0,196	0,208	0,221	0,233
0,096	0,102	0,109	0,117	0,125	0,134	0,144	0,154	0,164	0,176	0,187	0,199	0,211	0,223

(Source: Eisenbahnbundesamt [8])

Table 3.5.1-3: Geometry data for source height B: 4m (eq. 3.8, eq. 3.10 and eq. 3:11) (Source: Eisenbahnbundesamt [8])

Segment Coordinates			Geometry			
x (m)	y (m)	z (m)	phi (°)	Δ $L_{W,dir,hor,B}$ (dB)	Psi (°)	Δ $L_{W,dir,vert,B}$ dB(A)
0	-100	0	14,036	-11,660	-0,278	0,000
0	-95	0	14,744	-11,301	-0,292	0,000
0	-90	0	15,524	-10,920	-0,307	0,000
0	-85	0	16,390	-10,515	-0,323	0,000
0	-80	0	17,354	-10,084	-0,342	0,000
0	-75	0	18,435	-9,626	-0,362	0,000
0	-70	0	19,654	-9,137	-0,385	0,000
0	-65	0	21,038	-8,615	-0,411	0,000
0	-60	0	22,620	-8,056	-0,441	0,000
0	-55	0	24,444	-7,459	-0,474	0,000
0	-50	0	26,565	-6,819	-0,512	0,000
0	-45	0	29,055	-6,135	-0,556	0,000
0	-40	0	32,005	-5,405	-0,607	0,000
0	-35	0	35,538	-4,629	-0,666	-0,001
0	-30	0	39,806	-3,812	-0,734	-0,001
0	-25	0	45,000	-2,967	-0,810	-0,001
0	-20	0	51,340	-2,121	-0,895	-0,001
0	-15	0	59,036	-1,320	-0,983	-0,001
0	-10	0	68,199	-0,638	-1,064	-0,001
0	-5	0	78,690	-0,169	-1,124	-0,002
0	0	0	90,000	0,000	-1,146	-0,002
0	5	0	101,310	-0,169	-1,124	-0,002
0	10	0	111,801	-0,638	-1,064	-0,001
0	15	0	120,964	-1,320	-0,983	-0,001
0	20	0	128,660	-2,121	-0,895	-0,001
0	25	0	135,000	-2,967	-0,810	-0,001
0	30	0	140,194	-3,812	-0,734	-0,001
0	35	0	144,462	-4,629	-0,666	-0,001
0	40	0	147,995	-5,405	-0,607	0,000
0	45	0	150,945	-6,135	-0,556	0,000
0	50	0	153,435	-6,819	-0,512	0,000
0	55	0	155,556	-7,459	-0,474	0,000
0	60	0	157,380	-8,056	-0,441	0,000
0	65	0	158,962	-8,615	-0,411	0,000
0	70	0	160,346	-9,137	-0,385	0,000
0	75	0	161,565	-9,626	-0,362	0,000
0	80	0	162,646	-10,084	-0,342	0,000
0	85	0	163,610	-10,515	-0,323	0,000
0	90	0	164,476	-10,920	-0,307	0,000
0	95	0	165,256	-11,301	-0,292	0,000
0	100	0	165,964	-11,660	-0,278	0,000

With the emission data for the source height A (0.5m) shown in the diagram Table 3.5.1-2 the following values result for the directional sound power.

Table 3.5.1-4: Directional sound power level per meter for source height A: 0.5m (eq. 3.4.) (Source: Eisenbahnbundesamt [8])

(Table is continued on next page)

Segment Coordinates													
x (m)	y (m)	z (m)	50 Hz	63 Hz	80 Hz	100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz
0	-100	0	46,566	47,280	49,936	51,932	50,359	50,619	51,310	53,635	53,906	54,957	55,418
0	-95	0	46,929	47,642	50,299	52,295	50,722	50,982	51,674	53,998	54,270	55,321	55,782
0	-90	0	47,313	48,027	50,683	52,680	51,107	51,367	52,059	54,383	54,655	55,706	56,168
0	-85	0	47,722	48,436	51,092	53,089	51,516	51,777	52,468	54,793	55,065	56,117	56,578
0	-80	0	48,157	48,871	51,527	53,524	51,951	52,212	52,904	55,229	55,501	56,553	57,015
0	-75	0	48,620	49,334	51,991	53,988	52,415	52,676	53,368	55,693	55,966	57,018	57,481
0	-70	0	49,115	49,829	52,486	54,483	52,910	53,171	53,864	56,189	56,462	57,515	57,978
0	-65	0	49,643	50,357	53,014	55,011	53,439	53,700	54,393	56,719	56,992	58,045	58,509
0	-60	0	50,208	50,922	53,580	55,577	54,005	54,266	54,959	57,285	57,559	58,613	59,077
0	-55	0	50,813	51,528	54,185	56,183	54,611	54,873	55,566	57,892	58,167	59,221	59,686
0	-50	0	51,462	52,176	54,834	56,832	55,260	55,522	56,216	58,543	58,818	59,873	60,338
0	-45	0	52,156	52,871	55,529	57,527	55,955	56,218	56,912	59,240	59,515	60,571	61,037
0	-40	0	52,898	53,613	56,271	58,270	56,699	56,962	57,656	59,984	60,261	61,317	61,785
0	-35	0	53,688	54,403	57,062	59,060	57,489	57,753	58,448	60,777	61,055	62,112	62,580
0	-30	0	54,520	55,236	57,894	59,893	58,323	58,588	59,283	61,613	61,891	62,950	63,419
0	-25	0	55,382	56,098	58,757	60,757	59,187	59,452	60,149	62,479	62,758	63,818	64,289
0	-20	0	56,248	56,964	59,623	61,623	60,054	60,320	61,017	63,349	63,629	64,691	65,163
0	-15	0	57,068	57,784	60,444	62,445	60,876	61,143	61,841	64,173	64,455	65,518	65,992
0	-10	0	57,768	58,484	61,145	63,146	61,578	61,845	62,544	64,877	65,160	66,224	66,700
0	-5	0	58,250	58,967	61,627	63,628	62,061	62,329	63,028	65,362	65,646	66,711	67,188
0	0	0	58,423	59,140	61,801	63,802	62,234	62,503	63,202	65,537	65,821	66,886	67,363
0	5	0	58,250	58,967	61,627	63,628	62,061	62,329	63,028	65,362	65,646	66,711	67,188
0	10	0	57,768	58,484	61,145	63,146	61,578	61,845	62,544	64,877	65,160	66,224	66,700
0	15	0	57,068	57,784	60,444	62,445	60,876	61,143	61,841	64,173	64,455	65,518	65,992
0	20	0	56,248	56,964	59,623	61,623	60,054	60,320	61,017	63,349	63,629	64,691	65,163
0	25	0	55,382	56,098	58,757	60,757	59,187	59,452	60,149	62,479	62,758	63,818	64,289
0	30	0	54,520	55,236	57,894	59,893	58,323	58,588	59,283	61,613	61,891	62,950	63,419
0	35	0	53,688	54,403	57,062	59,060	57,489	57,753	58,448	60,777	61,055	62,112	62,580
0	40	0	52,898	53,613	56,271	58,270	56,699	56,962	57,656	59,984	60,261	61,317	61,785
0	45	0	52,156	52,871	55,529	57,527	55,955	56,218	56,912	59,240	59,515	60,571	61,037
0	50	0	51,462	52,176	54,834	56,832	55,260	55,522	56,216	58,543	58,818	59,873	60,338
0	55	0	50,813	51,528	54,185	56,183	54,611	54,873	55,566	57,892	58,167	59,221	59,686
0	60	0	50,208	50,922	53,580	55,577	54,005	54,266	54,959	57,285	57,559	58,613	59,077
0	65	0	49,643	50,357	53,014	55,011	53,439	53,700	54,393	56,719	56,992	58,045	58,509
0	70	0	49,115	49,829	52,486	54,483	52,910	53,171	53,864	56,189	56,462	57,515	57,978
0	75	0	48,620	49,334	51,991	53,988	52,415	52,676	53,368	55,693	55,966	57,018	57,481
0	80	0	48,157	48,871	51,527	53,524	51,951	52,212	52,904	55,229	55,501	56,553	57,015
0	85	0	47,722	48,436	51,092	53,089	51,516	51,777	52,468	54,793	55,065	56,117	56,578
0	90	0	47,313	48,027	50,683	52,680	51,107	51,367	52,059	54,383	54,655	55,706	56,168
0	95	0	46,929	47,642	50,299	52,295	50,722	50,982	51,674	53,998	54,270	55,321	55,782
0	100	0	46,566	47,280	49,936	51,932	50,359	50,619	51,310	53,635	53,906	54,957	55,418

Geometry												
$L_{W',dir,A,f}$												
630 Hz	800 Hz	1000 Hz	1250 Hz	1600 Hz	2000 Hz	2500 Hz	3150 Hz	4000 Hz	5000 Hz	6300 Hz	8000 Hz	10000 Hz
55,632	58,339	59,783	60,560	60,157	61,474	62,321	61,617	57,529	54,828	52,498	50,957	49,712
55,996	58,703	60,148	60,926	60,523	61,841	62,688	61,984	57,896	55,196	52,867	51,327	50,083
56,382	59,090	60,536	61,313	60,912	62,229	63,078	62,374	58,287	55,587	53,259	51,719	50,476
56,793	59,502	60,947	61,726	61,324	62,643	63,492	62,789	58,702	56,003	53,675	52,137	50,894
57,230	59,939	61,386	62,164	61,764	63,083	63,932	63,230	59,144	56,446	54,119	52,581	51,339
57,696	60,406	61,853	62,632	62,232	63,552	64,402	63,701	59,616	56,918	54,592	53,055	51,814
58,194	60,904	62,351	63,131	62,732	64,053	64,904	64,203	60,119	57,423	55,097	53,562	52,321
58,725	61,436	62,884	63,665	63,267	64,588	65,440	64,741	60,658	57,962	55,638	54,103	52,864
59,294	62,006	63,455	64,236	63,839	65,161	66,014	65,316	61,234	58,540	56,217	54,683	53,445
59,904	62,616	64,066	64,849	64,452	65,776	66,630	65,933	61,853	59,159	56,838	55,306	54,069
60,557	63,270	64,721	65,505	65,110	66,435	67,290	66,595	62,516	59,824	57,504	55,974	54,739
61,257	63,972	65,424	66,208	65,815	67,141	67,998	67,304	63,227	60,537	58,219	56,691	55,457
62,006	64,721	66,175	66,961	66,570	67,897	68,756	68,064	63,989	61,301	58,985	57,459	56,228
62,803	65,520	66,975	67,763	67,373	68,703	69,564	68,874	64,801	62,115	59,802	58,278	57,049
63,643	66,362	67,819	68,609	68,221	69,553	70,416	69,729	65,659	62,976	60,665	59,144	57,918
64,515	67,236	68,694	69,486	69,102	70,436	71,301	70,617	66,550	63,870	61,562	60,044	58,821
65,390	68,113	69,574	70,368	69,986	71,324	72,192	71,511	67,447	64,770	62,465	60,951	59,732
66,221	68,946	70,409	71,206	70,827	72,167	73,038	72,360	68,299	65,626	63,325	61,814	60,598
66,931	69,658	71,123	71,922	71,545	72,888	73,761	73,086	69,029	66,358	64,060	62,553	61,340
67,420	70,148	71,614	72,415	72,040	73,385	74,260	73,587	69,532	66,863	64,568	63,063	61,852
67,595	70,324	71,791	72,593	72,219	73,564	74,440	73,768	69,713	67,045	64,751	63,247	62,037
67,420	70,148	71,614	72,415	72,040	73,385	74,260	73,587	69,532	66,863	64,568	63,063	61,852
66,931	69,658	71,123	71,922	71,545	72,888	73,761	73,086	69,029	66,358	64,060	62,553	61,340
66,221	68,946	70,409	71,206	70,827	72,167	73,038	72,360	68,299	65,626	63,325	61,814	60,598
65,390	68,113	69,574	70,368	69,986	71,324	72,192	71,511	67,447	64,770	62,465	60,951	59,732
64,515	67,236	68,694	69,486	69,102	70,436	71,301	70,617	66,550	63,870	61,562	60,044	58,821
63,643	66,362	67,819	68,609	68,221	69,553	70,416	69,729	65,659	62,976	60,665	59,144	57,918
62,803	65,520	66,975	67,763	67,373	68,703	69,564	68,874	64,801	62,115	59,802	58,278	57,049
62,006	64,721	66,175	66,961	66,570	67,897	68,756	68,064	63,989	61,301	58,985	57,459	56,228
61,257	63,972	65,424	66,208	65,815	67,141	67,998	67,304	63,227	60,537	58,219	56,691	55,457
60,557	63,270	64,721	65,505	65,110	66,435	67,290	66,595	62,516	59,824	57,504	55,974	54,739
59,904	62,616	64,066	64,849	64,452	65,776	66,630	65,933	61,853	59,159	56,838	55,306	54,069
59,294	62,006	63,455	64,236	63,839	65,161	66,014	65,316	61,234	58,540	56,217	54,683	53,445
58,725	61,436	62,884	63,665	63,267	64,588	65,440	64,741	60,658	57,962	55,638	54,103	52,864
58,194	60,904	62,351	63,131	62,732	64,053	64,904	64,203	60,119	57,423	55,097	53,562	52,321
57,696	60,406	61,853	62,632	62,232	63,552	64,402	63,701	59,616	56,918	54,592	53,055	51,814
57,230	59,939	61,386	62,164	61,764	63,083	63,932	63,230	59,144	56,446	54,119	52,581	51,339
56,793	59,502	60,947	61,726	61,324	62,643	63,492	62,789	58,702	56,003	53,675	52,137	50,894
56,382	59,090	60,536	61,313	60,912	62,229	63,078	62,374	58,287	55,587	53,259	51,719	50,476
55,996	58,703	60,148	60,926	60,523	61,841	62,688	61,984	57,896	55,196	52,867	51,327	50,083
55,632	58,339	59,783	60,560	60,157	61,474	62,321	61,617	57,529	54,828	52,498	50,957	49,712

(Source: Eisenbahnbundesamt [8])

With the emission data for the source height B (4m) shown in the diagram Table 3.5.2-3 the following values result for the directional sound power.

Table 3.5.1-5: Directional sound power level per meter for source height B: 4m (eq. 3.4.) (Source: Eisenbahnbundesamt [8])

(Table is continued on next page)

Segment Coordinates													
x (m)	y (m)	z (m)	50 Hz	63 Hz	80 Hz	100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz
0	-100	0	18,369	20,169	16,969	15,169	14,069	14,069	13,069	27,869	11,869	11,969	27,969
0	-95	0	18,728	20,528	17,328	15,528	14,428	14,428	13,428	28,228	12,228	12,328	28,328
0	-90	0	19,109	20,909	17,709	15,909	14,809	14,809	13,809	28,609	12,609	12,709	28,709
0	-85	0	19,514	21,314	18,114	16,314	15,214	15,214	14,214	29,014	13,014	13,114	29,114
0	-80	0	19,945	21,745	18,545	16,745	15,645	15,645	14,645	29,445	13,445	13,545	29,545
0	-75	0	20,403	22,203	19,003	17,203	16,103	16,103	15,103	29,903	13,903	14,003	30,003
0	-70	0	20,892	22,692	19,492	17,692	16,592	16,592	15,592	30,392	14,392	14,492	30,492
0	-65	0	21,414	23,214	20,014	18,214	17,114	17,114	16,114	30,914	14,915	15,015	31,014
0	-60	0	21,973	23,773	20,573	18,773	17,673	17,673	16,673	31,473	15,473	15,573	31,573
0	-55	0	22,570	24,370	21,170	19,370	18,270	18,270	17,270	32,070	16,070	16,170	32,170
0	-50	0	23,209	25,009	21,810	20,010	18,910	18,910	17,910	32,709	16,710	16,810	32,809
0	-45	0	23,894	25,694	22,494	20,694	19,594	19,594	18,594	33,394	17,394	17,494	33,494
0	-40	0	24,624	26,424	23,224	21,424	20,324	20,324	19,324	34,124	18,124	18,224	34,224
0	-35	0	25,400	27,200	24,000	22,200	21,100	21,100	20,100	34,900	18,900	19,000	35,000
0	-30	0	26,217	28,017	24,817	23,017	21,917	21,917	20,917	35,717	19,717	19,817	35,817
0	-25	0	27,062	28,862	25,662	23,862	22,762	22,762	21,762	36,562	20,562	20,662	36,662
0	-20	0	27,908	29,708	26,508	24,708	23,608	23,608	22,608	37,408	21,408	21,508	37,508
0	-15	0	28,709	30,509	27,309	25,509	24,409	24,409	23,409	38,209	22,209	22,309	38,309
0	-10	0	29,391	31,191	27,991	26,191	25,091	25,091	24,091	38,891	22,891	22,991	38,991
0	-5	0	29,860	31,660	28,460	26,660	25,560	25,560	24,560	39,360	23,360	23,460	39,460
0	0	0	30,029	31,829	28,629	26,829	25,729	25,729	24,729	39,529	23,529	23,629	39,629
0	5	0	29,860	31,660	28,460	26,660	25,560	25,560	24,560	39,360	23,360	23,460	39,460
0	10	0	29,391	31,191	27,991	26,191	25,091	25,091	24,091	38,891	22,891	22,991	38,991
0	15	0	28,709	30,509	27,309	25,509	24,409	24,409	23,409	38,209	22,209	22,309	38,309
0	20	0	27,908	29,708	26,508	24,708	23,608	23,608	22,608	37,408	21,408	21,508	37,508
0	25	0	27,062	28,862	25,662	23,862	22,762	22,762	21,762	36,562	20,562	20,662	36,662
0	30	0	26,217	28,017	24,817	23,017	21,917	21,917	20,917	35,717	19,717	19,817	35,817
0	35	0	25,400	27,200	24,000	22,200	21,100	21,100	20,100	34,900	18,900	19,000	35,000
0	40	0	24,624	26,424	23,224	21,424	20,324	20,324	19,324	34,124	18,124	18,224	34,224
0	45	0	23,894	25,694	22,494	20,694	19,594	19,594	18,594	33,394	17,394	17,494	33,494
0	50	0	23,209	25,009	21,810	20,010	18,910	18,910	17,910	32,709	16,710	16,810	32,809
0	55	0	22,570	24,370	21,170	19,370	18,270	18,270	17,270	32,070	16,070	16,170	32,170
0	60	0	21,973	23,773	20,573	18,773	17,673	17,673	16,673	31,473	15,473	15,573	31,573
0	65	0	21,414	23,214	20,014	18,214	17,114	17,114	16,114	30,914	14,915	15,015	31,014
0	70	0	20,892	22,692	19,492	17,692	16,592	16,592	15,592	30,392	14,392	14,492	30,492
0	75	0	20,403	22,203	19,003	17,203	16,103	16,103	15,103	29,903	13,903	14,003	30,003
0	80	0	19,945	21,745	18,545	16,745	15,645	15,645	14,645	29,445	13,445	13,545	29,545
0	85	0	19,514	21,314	18,114	16,314	15,214	15,214	14,214	29,014	13,014	13,114	29,114
0	90	0	19,109	20,909	17,709	15,909	14,809	14,809	13,809	28,609	12,609	12,709	28,709
0	95	0	18,728	20,528	17,328	15,528	14,428	14,428	13,428	28,228	12,228	12,328	28,328
0	100	0	18,369	20,169	16,969	15,169	14,069	14,069	13,069	27,869	11,869	11,969	27,969

Geometry												
$L_{W',dir,B,f}$												
630 Hz	800 Hz	1000 Hz	1250 Hz	1600 Hz	2000 Hz	2500 Hz	3150 Hz	4000 Hz	5000 Hz	6300 Hz	8000 Hz	10000 Hz
11,269	10,869	18,169	13,069	38,788	43,873	43,971	39,172	4,871	2,172	-0,424	-2,918	-5,104
11,628	11,228	18,528	13,428	39,147	44,232	44,330	39,531	5,230	2,531	-0,065	-2,559	-4,745
12,009	11,610	18,909	13,809	39,528	44,613	44,711	39,912	5,611	2,913	0,316	-2,177	-4,364
12,414	12,014	19,314	14,214	39,933	45,018	45,116	40,317	6,016	3,317	0,721	-1,773	-3,959
12,845	12,445	19,745	14,645	40,364	45,448	45,546	40,747	6,446	3,748	1,151	-1,342	-3,529
13,303	12,903	20,203	15,103	40,822	45,907	46,005	41,206	6,905	4,206	1,610	-0,884	-3,070
13,792	13,392	20,692	15,592	41,311	46,396	46,494	41,695	7,394	4,695	2,099	-0,395	-2,581
14,315	13,915	21,214	16,114	41,833	46,918	47,016	42,217	7,916	5,218	2,621	0,128	-2,059
14,873	14,473	21,773	16,673	42,392	47,476	47,574	42,775	8,474	5,776	3,179	0,686	-1,501
15,470	15,070	22,370	17,270	42,989	48,074	48,172	43,373	9,072	6,373	3,777	1,283	-0,903
16,110	15,710	23,009	17,910	43,628	48,713	48,811	44,012	9,711	7,013	4,416	1,923	-0,264
16,794	16,394	23,694	18,594	44,313	49,397	49,495	44,696	10,395	7,697	5,100	2,607	0,420
17,524	17,124	24,424	19,324	45,043	50,127	50,226	45,427	11,126	8,427	5,831	3,337	1,151
18,300	17,901	25,200	20,100	45,819	50,903	51,002	46,203	11,902	9,204	6,607	4,114	1,927
19,117	18,717	26,017	20,917	46,636	51,720	51,818	47,019	12,719	10,020	7,424	4,930	2,744
19,962	19,562	26,862	21,762	47,480	52,565	52,663	47,864	13,563	10,865	8,268	5,775	3,588
20,808	20,408	27,708	22,608	48,326	53,411	53,509	48,710	14,410	11,711	9,115	6,621	4,435
21,609	21,209	28,509	23,409	49,127	54,212	54,310	49,511	15,211	12,512	9,916	7,422	5,236
22,291	21,891	29,191	24,091	49,809	54,894	54,992	50,193	15,893	13,195	10,598	8,105	5,918
22,761	22,361	29,660	24,560	50,278	55,362	55,460	50,662	16,362	13,664	11,067	8,574	6,387
22,929	22,529	29,829	24,729	50,446	55,531	55,629	50,830	16,530	13,832	11,236	8,742	6,555
22,761	22,361	29,660	24,560	50,278	55,362	55,460	50,662	16,362	13,664	11,067	8,574	6,387
22,291	21,891	29,191	24,091	49,809	54,894	54,992	50,193	15,893	13,195	10,598	8,105	5,918
21,609	21,209	28,509	23,409	49,127	54,212	54,310	49,511	15,211	12,512	9,916	7,422	5,236
20,808	20,408	27,708	22,608	48,326	53,411	53,509	48,710	14,410	11,711	9,115	6,621	4,435
19,962	19,562	26,862	21,762	47,480	52,565	52,663	47,864	13,563	10,865	8,268	5,775	3,588
19,117	18,717	26,017	20,917	46,636	51,720	51,818	47,019	12,719	10,020	7,424	4,930	2,744
18,300	17,901	25,200	20,100	45,819	50,903	51,002	46,203	11,902	9,204	6,607	4,114	1,927
17,524	17,124	24,424	19,324	45,043	50,127	50,226	45,427	11,126	8,427	5,831	3,337	1,151
16,794	16,394	23,694	18,594	44,313	49,397	49,495	44,696	10,395	7,697	5,100	2,607	0,420
16,110	15,710	23,009	17,910	43,628	48,713	48,811	44,012	9,711	7,013	4,416	1,923	-0,264
15,470	15,070	22,370	17,270	42,989	48,074	48,172	43,373	9,072	6,373	3,777	1,283	-0,903
14,873	14,473	21,773	16,673	42,392	47,476	47,574	42,775	8,474	5,776	3,179	0,686	-1,501
14,315	13,915	21,214	16,114	41,833	46,918	47,016	42,217	7,916	5,218	2,621	0,128	-2,059
13,792	13,392	20,692	15,592	41,311	46,396	46,494	41,695	7,394	4,695	2,099	-0,395	-2,581
13,303	12,903	20,203	15,103	40,822	45,907	46,005	41,206	6,905	4,206	1,610	-0,884	-3,070
12,845	12,445	19,745	14,645	40,364	45,448	45,546	40,747	6,446	3,748	1,151	-1,342	-3,529
12,414	12,014	19,314	14,214	39,933	45,018	45,116	40,317	6,016	3,317	0,721	-1,773	-3,959
12,009	11,610	18,909	13,809	39,528	44,613	44,711	39,912	5,611	2,913	0,316	-2,177	-4,364
11,628	11,228	18,528	13,428	39,147	44,232	44,330	39,531	5,230	2,531	-0,065	-2,559	-4,745
11,269	10,869	18,169	13,069	38,788	43,873	43,971	39,172	4,871	2,172	-0,424	-2,918	-5,104

(Source: Eisenbahnbundesamt [8])

For the dispersion calculation, the emission data shown in Table 3.5.2-4 and Table 3.5.2-5 are summarized in octaves.

Table 3.5.1-6: Directional sound power level per meter for source heights A and B are summarized in octaves (eq. 3.4.) (Source: Eisenbahnbundesamt [8])

(Table is continued on next page)

Segment Coordinates			$L_{W',dir,A,f}$							
x (m)	y (m)	z (m)	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
0	-100	0	52,952	55,797	57,867	60,116	64,426	66,178	63,657	55,977
0	-95	0	53,315	56,160	58,231	60,480	64,792	66,545	64,024	56,347
0	-90	0	53,699	56,545	58,616	60,866	65,179	66,934	64,415	56,739
0	-85	0	54,108	56,955	59,026	61,276	65,591	67,347	64,830	57,156
0	-80	0	54,543	57,390	59,462	61,713	66,029	67,787	65,271	57,600
0	-75	0	55,007	57,854	59,926	62,179	66,497	68,256	65,743	58,074
0	-70	0	55,502	58,349	60,422	62,676	66,995	68,757	66,245	58,580
0	-65	0	56,030	58,877	60,952	63,207	67,528	69,293	66,784	59,121
0	-60	0	56,595	59,443	61,518	63,775	68,099	69,866	67,359	59,701
0	-55	0	57,201	60,050	62,126	64,384	68,710	70,481	67,977	60,324
0	-50	0	57,849	60,699	62,776	65,036	69,366	71,140	68,640	60,991
0	-45	0	58,544	61,394	63,473	65,736	70,068	71,847	69,350	61,708
0	-40	0	59,286	62,138	64,218	66,483	70,820	72,603	70,111	62,475
0	-35	0	60,077	62,928	65,011	67,279	71,620	73,409	70,922	63,294
0	-30	0	60,909	63,762	65,847	68,118	72,465	74,260	71,778	64,159
0	-25	0	61,771	64,626	66,713	68,988	73,340	75,143	72,668	65,059
0	-20	0	62,637	65,493	67,583	69,862	74,220	76,031	73,563	65,965
0	-15	0	63,458	66,315	68,408	70,691	75,056	76,875	74,414	66,827
0	-10	0	64,158	67,016	69,112	71,399	75,770	77,596	75,142	67,565
0	-5	0	64,641	67,499	69,597	71,887	76,262	78,093	75,644	68,075
0	0	0	64,814	67,673	69,772	72,062	76,439	78,273	75,825	68,259
0	5	0	64,641	67,499	69,597	71,887	76,262	78,093	75,644	68,075
0	10	0	64,158	67,016	69,112	71,399	75,770	77,596	75,142	67,565
0	15	0	63,458	66,315	68,408	70,691	75,056	76,875	74,414	66,827
0	20	0	62,637	65,493	67,583	69,862	74,220	76,031	73,563	65,965
0	25	0	61,771	64,626	66,713	68,988	73,340	75,143	72,668	65,059
0	30	0	60,909	63,762	65,847	68,118	72,465	74,260	71,778	64,159
0	35	0	60,077	62,928	65,011	67,279	71,620	73,409	70,922	63,294
0	40	0	59,286	62,138	64,218	66,483	70,820	72,603	70,111	62,475
0	45	0	58,544	61,394	63,473	65,736	70,068	71,847	69,350	61,708
0	50	0	57,849	60,699	62,776	65,036	69,366	71,140	68,640	60,991
0	55	0	57,201	60,050	62,126	64,384	68,710	70,481	67,977	60,324
0	60	0	56,595	59,443	61,518	63,775	68,099	69,866	67,359	59,701
0	65	0	56,030	58,877	60,952	63,207	67,528	69,293	66,784	59,121
0	70	0	55,502	58,349	60,422	62,676	66,995	68,757	66,245	58,580
0	75	0	55,007	57,854	59,926	62,179	66,497	68,256	65,743	58,074
0	80	0	54,543	57,390	59,462	61,713	66,029	67,787	65,271	57,600
0	85	0	54,108	56,955	59,026	61,276	65,591	67,347	64,830	57,156
0	90	0	53,699	56,545	58,616	60,866	65,179	66,934	64,415	56,739
0	95	0	53,315	56,160	58,231	60,480	64,792	66,545	64,024	56,347
0	100	0	52,952	55,797	57,867	60,116	64,426	66,178	63,657	55,977

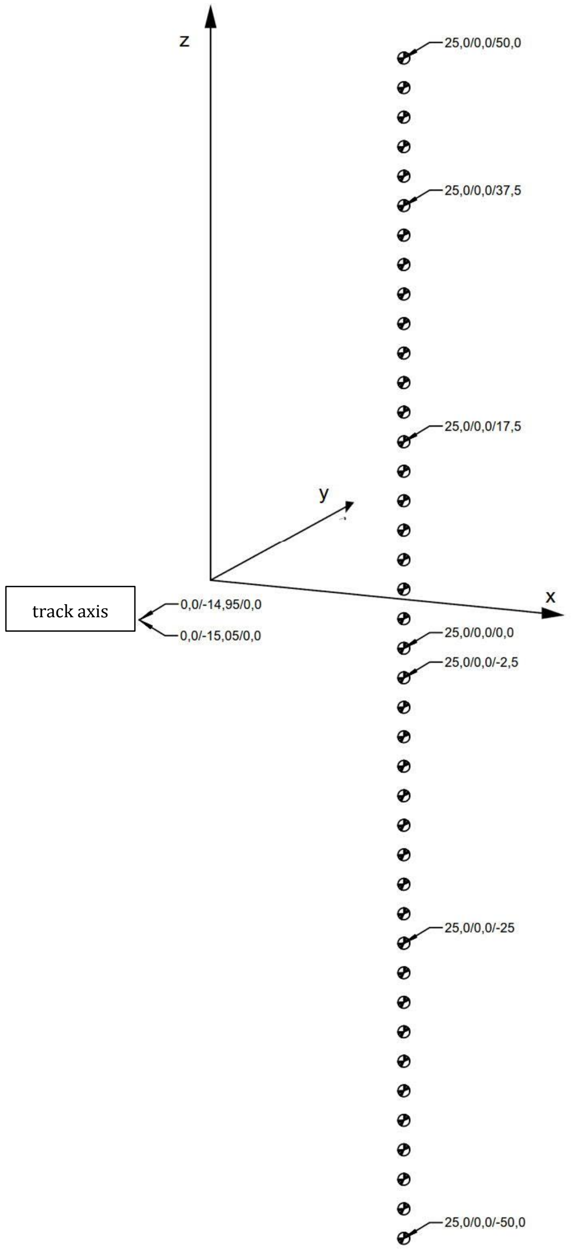
$L_{W',dir,B,f}$							
63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
23,472	19,239	28,115	28,166	19,916	47,552	39,174	2,372
23,831	19,598	28,474	28,525	20,275	47,911	39,533	2,731
24,212	19,979	28,855	28,906	20,656	48,292	39,914	3,112
24,617	20,384	29,260	29,311	21,061	48,697	40,319	3,517
25,048	20,815	29,691	29,742	21,492	49,127	40,749	3,947
25,506	21,273	30,149	30,200	21,950	49,586	41,208	4,406
25,995	21,762	30,638	30,689	22,439	50,075	41,697	4,895
26,517	22,284	31,160	31,211	22,961	50,597	42,219	5,417
27,076	22,843	31,719	31,770	23,520	51,155	42,777	5,975
27,673	23,440	32,316	32,367	24,117	51,753	43,375	6,573
28,312	24,080	32,955	33,006	24,756	52,392	44,014	7,212
28,997	24,764	33,640	33,691	25,441	53,076	44,698	7,896
29,727	25,494	34,370	34,421	26,171	53,807	45,429	8,627
30,503	26,270	35,146	35,197	26,947	54,583	46,205	9,403
31,320	27,087	35,963	36,014	27,764	55,399	47,021	10,220
32,165	27,932	36,808	36,859	28,609	56,244	47,866	11,064
33,011	28,778	37,654	37,705	29,455	57,090	48,712	11,911
33,812	29,579	38,455	38,506	30,256	57,891	49,513	12,712
34,494	30,261	39,137	39,188	30,938	58,573	50,195	13,394
34,963	30,730	39,606	39,657	31,407	59,041	50,664	13,863
35,132	30,899	39,775	39,826	31,576	59,210	50,832	14,031
34,963	30,730	39,606	39,657	31,407	59,041	50,664	13,863
34,494	30,261	39,137	39,188	30,938	58,573	50,195	13,394
33,812	29,579	38,455	38,506	30,256	57,891	49,513	12,712
33,011	28,778	37,654	37,705	29,455	57,090	48,712	11,911
32,165	27,932	36,808	36,859	28,609	56,244	47,866	11,064
31,320	27,087	35,963	36,014	27,764	55,399	47,021	10,220
30,503	26,270	35,146	35,197	26,947	54,583	46,205	9,403
29,727	25,494	34,370	34,421	26,171	53,807	45,429	8,627
28,997	24,764	33,640	33,691	25,441	53,076	44,698	7,896
28,312	24,080	32,955	33,006	24,756	52,392	44,014	7,212
27,673	23,440	32,316	32,367	24,117	51,753	43,375	6,573
27,076	22,843	31,719	31,770	23,520	51,155	42,777	5,975
26,517	22,284	31,160	31,211	22,961	50,597	42,219	5,417
25,995	21,762	30,638	30,689	22,439	50,075	41,697	4,895
25,506	21,273	30,149	30,200	21,950	49,586	41,208	4,406
25,048	20,815	29,691	29,742	21,492	49,127	40,749	3,947
24,617	20,384	29,260	29,311	21,061	48,697	40,319	3,517
24,212	19,979	28,855	28,906	20,656	48,292	39,914	3,112
23,831	19,598	28,474	28,525	20,275	47,911	39,533	2,731
23,472	19,239	28,115	28,166	19,916	47,552	39,174	2,372

(Source: Eisenbahnbundesamt [8])

3.5.2 Test Case 3.2: Vertical directivity for a straight section of track

Test case 3.2: Vertical directivity for different heights of immission points for a short section of a track

Figure 3.5.2-1: Vertical directivity (Source: Eisenbahnbundesamt [8])



For rail vehicles, Table 3.2 applies:

- Number of units of vehicle type t: *1*
- Vehicle type: *High speed vehicle according to Table 3.2 (h2)*
- Number of axles per vehicle: *Na = 32 according to Schall 03, Supplement 1, vehicle category 4*
- Speed: *300 km/h*
- Brake type: *Wheel disc brake or shaft disc brake according to Table 3.2 (n)*
- Measures relating to the wheels: no measure (n)

For track type according to Table 3.3:

- Superstructure: Concrete sleepers in ballast bed (B)
- Railhead roughness: average rail condition (normally maintained and smooth) (A)
- Type of rail pad: Medium (250 to 800 MN/m) (M)
- Additional measures: None (N)
- Rail joints: None (N)
- Curvature: Low (R ≥ 500m) (KN)

Table 3.5.2-1: Coordinates of ground level, track axis and point of immission (Source: Eisenbahnbundesamt [8])

	x	y	z
Ground elevation			0.0
Start of track axis	0.0	-14.95	0.0
End of track axis	0.0	-15.05	0.0

Table 3.5.2-2: Geometry data for source height A: 0.5m (according to eq. 3.8 and eq. 3.9.) (Source: Eisenbahnbundesamt [8])

(Table is continued on next page)

Coordinates Place of Immision														
x (m)	y (m)	z (m)	phi (°)	Δ $L_{W,dir,hor,A}$ (dB)	Psi (°)	50 Hz	63 Hz	80 Hz	100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz
25	0	-50	59,036	-1,320	-60,001	-1,970	-2,004	-2,046	-2,094	-2,153	-2,232	-2,318	-2,419	-2,542
25	0	-47,5	59,036	-1,320	-58,726	-1,796	-1,826	-1,864	-1,909	-1,962	-2,034	-2,112	-2,204	-2,317
25	0	-45	59,036	-1,320	-57,350	-1,613	-1,640	-1,675	-1,714	-1,762	-1,827	-1,897	-1,980	-2,081
25	0	-42,5	59,036	-1,320	-55,862	-1,422	-1,446	-1,477	-1,512	-1,554	-1,611	-1,673	-1,746	-1,835
25	0	-40	59,036	-1,320	-54,251	-1,224	-1,245	-1,271	-1,301	-1,338	-1,387	-1,440	-1,503	-1,579
25	0	-37,5	59,036	-1,320	-52,503	-1,020	-1,037	-1,059	-1,084	-1,115	-1,155	-1,200	-1,252	-1,316
25	0	-35	59,036	-1,320	-50,605	-0,811	-0,825	-0,842	-0,862	-0,886	-0,919	-0,954	-0,996	-1,046
25	0	-32,5	59,036	-1,320	-48,540	-0,599	-0,610	-0,622	-0,637	-0,655	-0,679	-0,705	-0,736	-0,773
25	0	-30	59,036	-1,320	-46,292	-0,388	-0,395	-0,403	-0,413	-0,424	-0,440	-0,457	-0,477	-0,501
25	0	-27,5	59,036	-1,320	-43,843	-0,181	-0,184	-0,188	-0,193	-0,198	-0,205	-0,213	-0,223	-0,234
25	0	-25	59,036	-1,320	-41,174	0,016	0,017	0,017	0,017	0,018	0,018	0,019	0,020	0,021
25	0	-22,5	59,036	-1,320	-38,270	0,198	0,201	0,205	0,210	0,216	0,224	0,233	0,243	0,255
25	0	-20	59,036	-1,320	-35,113	0,356	0,362	0,370	0,378	0,389	0,403	0,419	0,437	0,459
25	0	-17,5	59,036	-1,320	-31,691	0,482	0,490	0,501	0,513	0,527	0,546	0,567	0,592	0,622
25	0	-15	59,036	-1,320	-27,997	0,568	0,578	0,590	0,604	0,621	0,643	0,668	0,697	0,733
25	0	-12,5	59,036	-1,320	-24,032	0,605	0,615	0,628	0,643	0,661	0,686	0,712	0,743	0,781
25	0	-10	59,036	-1,320	-19,806	0,588	0,598	0,611	0,625	0,643	0,667	0,692	0,722	0,759
25	0	-7,5	59,036	-1,320	-15,344	0,516	0,525	0,536	0,549	0,564	0,585	0,607	0,634	0,666
25	0	-5	59,036	-1,320	-10,683	0,393	0,399	0,408	0,417	0,429	0,445	0,462	0,482	0,506
25	0	-2,5	59,036	-1,320	-5,875	0,228	0,232	0,237	0,242	0,249	0,258	0,268	0,280	0,294
25	0	0	59,036	-1,320	-0,983	0,039	0,040	0,040	0,041	0,043	0,044	0,046	0,048	0,050
25	0	2,5	59,036	-1,320	3,924	0,154	0,157	0,160	0,164	0,169	0,175	0,181	0,189	0,199
25	0	5	59,036	-1,320	8,774	0,331	0,336	0,343	0,352	0,361	0,375	0,389	0,406	0,427
25	0	7,5	59,036	-1,320	13,501	0,472	0,480	0,491	0,502	0,516	0,535	0,556	0,580	0,609
25	0	10	59,036	-1,320	18,048	0,566	0,576	0,588	0,602	0,619	0,641	0,666	0,695	0,730
25	0	12,5	59,036	-1,320	22,372	0,605	0,615	0,628	0,643	0,661	0,685	0,712	0,743	0,781
25	0	15	59,036	-1,320	26,443	0,589	0,599	0,612	0,626	0,644	0,667	0,693	0,723	0,760
25	0	17,5	59,036	-1,320	30,246	0,522	0,531	0,542	0,555	0,570	0,591	0,614	0,641	0,673
25	0	20	59,036	-1,320	33,776	0,411	0,418	0,427	0,437	0,449	0,465	0,483	0,504	0,530
25	0	22,5	59,036	-1,320	37,038	0,264	0,269	0,275	0,281	0,289	0,299	0,311	0,325	0,341
25	0	25	59,036	-1,320	40,042	0,091	0,093	0,095	0,097	0,100	0,103	0,107	0,112	0,118
25	0	27,5	59,036	-1,320	42,803	-0,101	-0,102	-0,105	-0,107	-0,110	-0,114	-0,119	-0,124	-0,130
25	0	30	59,036	-1,320	45,337	-0,305	-0,310	-0,316	-0,324	-0,333	-0,345	-0,358	-0,374	-0,393
25	0	32,5	59,036	-1,320	47,664	-0,515	-0,523	-0,534	-0,547	-0,562	-0,583	-0,605	-0,632	-0,664
25	0	35	59,036	-1,320	49,800	-0,727	-0,739	-0,754	-0,772	-0,794	-0,823	-0,855	-0,892	-0,937
25	0	37,5	59,036	-1,320	51,763	-0,937	-0,953	-0,973	-0,996	-1,024	-1,061	-1,102	-1,150	-1,209
25	0	40	59,036	-1,320	53,569	-1,143	-1,162	-1,187	-1,215	-1,249	-1,295	-1,345	-1,403	-1,475
25	0	42,5	59,036	-1,320	55,233	-1,344	-1,366	-1,395	-1,428	-1,468	-1,522	-1,581	-1,650	-1,734
25	0	45	59,036	-1,320	56,769	-1,537	-1,563	-1,596	-1,634	-1,680	-1,741	-1,808	-1,887	-1,984
25	0	47,5	59,036	-1,320	58,188	-1,723	-1,752	-1,789	-1,832	-1,883	-1,952	-2,027	-2,116	-2,223
25	0	50	59,036	-1,320	59,503	-1,901	-1,933	-1,974	-2,021	-2,078	-2,154	-2,236	-2,334	-2,453

Geometry		Δ $L_{W,dir,vert,A,f}$												
400 Hz	500 Hz	630 Hz	800 Hz	1000 Hz	1250 Hz	1600 Hz	2000 Hz	2500 Hz	3150 Hz	4000 Hz	5000 Hz	6300 Hz	8000 Hz	10000 Hz
-2,691	-2,850	-3,037	-3,253	-3,476	-3,719	-4,009	-4,288	-4,582	-4,900	-5,242	-5,571	-5,920	-6,288	-6,637
-2,452	-2,597	-2,767	-2,965	-3,168	-3,389	-3,653	-3,908	-4,176	-4,466	-4,777	-5,077	-5,395	-5,730	-6,049
-2,202	-2,333	-2,486	-2,663	-2,845	-3,044	-3,281	-3,510	-3,750	-4,011	-4,290	-4,560	-4,845	-5,147	-5,433
-1,942	-2,057	-2,192	-2,348	-2,509	-2,684	-2,893	-3,095	-3,307	-3,537	-3,783	-4,021	-4,272	-4,538	-4,791
-1,672	-1,771	-1,887	-2,021	-2,160	-2,311	-2,491	-2,664	-2,847	-3,045	-3,257	-3,461	-3,678	-3,907	-4,124
-1,393	-1,475	-1,572	-1,684	-1,800	-1,925	-2,075	-2,220	-2,372	-2,537	-2,714	-2,884	-3,065	-3,255	-3,436
-1,108	-1,173	-1,250	-1,339	-1,431	-1,531	-1,650	-1,765	-1,886	-2,017	-2,158	-2,293	-2,437	-2,588	-2,732
-0,819	-0,867	-0,924	-0,990	-1,058	-1,132	-1,220	-1,305	-1,394	-1,491	-1,595	-1,695	-1,801	-1,913	-2,019
-0,530	-0,561	-0,598	-0,641	-0,685	-0,733	-0,790	-0,845	-0,903	-0,965	-1,033	-1,098	-1,166	-1,239	-1,308
-0,247	-0,262	-0,279	-0,299	-0,320	-0,342	-0,369	-0,394	-0,421	-0,451	-0,482	-0,512	-0,545	-0,578	-0,611
0,022	0,023	0,025	0,027	0,029	0,031	0,033	0,035	0,038	0,040	0,043	0,046	0,049	0,052	0,055
0,270	0,286	0,305	0,327	0,349	0,373	0,403	0,431	0,460	0,492	0,526	0,559	0,594	0,631	0,666
0,486	0,515	0,549	0,588	0,628	0,672	0,724	0,775	0,828	0,885	0,947	1,007	1,070	1,136	1,199
0,659	0,698	0,743	0,796	0,851	0,910	0,981	1,050	1,122	1,200	1,283	1,364	1,449	1,539	1,625
0,776	0,822	0,875	0,938	1,002	1,072	1,156	1,236	1,321	1,413	1,511	1,606	1,707	1,813	1,913
0,826	0,875	0,933	0,999	1,068	1,142	1,231	1,317	1,407	1,505	1,610	1,711	1,818	1,931	2,039
0,804	0,851	0,907	0,972	1,038	1,111	1,197	1,281	1,368	1,463	1,565	1,664	1,768	1,878	1,982
0,705	0,747	0,795	0,852	0,911	0,974	1,050	1,123	1,200	1,284	1,373	1,459	1,551	1,647	1,739
0,536	0,568	0,605	0,648	0,692	0,741	0,799	0,854	0,913	0,976	1,044	1,110	1,179	1,253	1,322
0,311	0,330	0,351	0,376	0,402	0,430	0,464	0,496	0,530	0,567	0,606	0,645	0,685	0,727	0,768
0,053	0,056	0,060	0,064	0,069	0,074	0,079	0,085	0,091	0,097	0,104	0,110	0,117	0,124	0,131
0,211	0,223	0,238	0,255	0,272	0,291	0,314	0,336	0,359	0,384	0,410	0,436	0,463	0,492	0,520
0,452	0,478	0,510	0,546	0,584	0,624	0,673	0,720	0,769	0,823	0,880	0,935	0,994	1,056	1,114
0,645	0,683	0,728	0,780	0,833	0,892	0,961	1,028	1,099	1,175	1,257	1,336	1,419	1,508	1,591
0,773	0,819	0,872	0,935	0,999	1,069	1,152	1,232	1,316	1,408	1,506	1,600	1,701	1,807	1,907
0,826	0,875	0,933	0,999	1,068	1,142	1,231	1,317	1,407	1,505	1,610	1,711	1,818	1,931	2,039
0,804	0,852	0,908	0,973	1,039	1,112	1,199	1,282	1,370	1,465	1,567	1,666	1,770	1,880	1,984
0,713	0,755	0,804	0,862	0,921	0,985	1,062	1,136	1,214	1,298	1,389	1,476	1,568	1,666	1,758
0,561	0,594	0,633	0,678	0,725	0,776	0,836	0,894	0,955	1,022	1,093	1,162	1,234	1,311	1,384
0,361	0,382	0,407	0,437	0,466	0,499	0,538	0,575	0,615	0,658	0,703	0,748	0,794	0,844	0,891
0,125	0,132	0,141	0,151	0,161	0,172	0,186	0,198	0,212	0,227	0,243	0,258	0,274	0,291	0,307
-0,138	-0,146	-0,155	-0,166	-0,178	-0,190	-0,205	-0,219	-0,234	-0,251	-0,268	-0,285	-0,303	-0,322	-0,340
-0,416	-0,441	-0,469	-0,503	-0,537	-0,575	-0,620	-0,663	-0,708	-0,758	-0,810	-0,861	-0,915	-0,972	-1,026
-0,703	-0,744	-0,793	-0,850	-0,908	-0,972	-1,047	-1,120	-1,197	-1,280	-1,369	-1,455	-1,546	-1,643	-1,734
-0,992	-1,051	-1,120	-1,200	-1,282	-1,371	-1,478	-1,581	-1,690	-1,807	-1,933	-2,054	-2,183	-2,319	-2,448
-1,279	-1,355	-1,444	-1,547	-1,653	-1,768	-1,906	-2,039	-2,179	-2,330	-2,493	-2,649	-2,815	-2,990	-3,156
-1,561	-1,654	-1,762	-1,887	-2,017	-2,158	-2,326	-2,488	-2,659	-2,843	-3,041	-3,232	-3,435	-3,648	-3,851
-1,835	-1,944	-2,071	-2,219	-2,371	-2,536	-2,734	-2,924	-3,125	-3,342	-3,575	-3,799	-4,037	-4,288	-4,527
-2,099	-2,224	-2,369	-2,538	-2,712	-2,902	-3,128	-3,346	-3,575	-3,823	-4,090	-4,347	-4,619	-4,906	-5,179
-2,353	-2,493	-2,656	-2,845	-3,041	-3,253	-3,506	-3,751	-4,008	-4,286	-4,585	-4,872	-5,178	-5,500	-5,805
-2,596	-2,750	-2,930	-3,139	-3,355	-3,589	-3,868	-4,138	-4,422	-4,729	-5,058	-5,376	-5,713	-6,068	-6,405

(Source: Eisenbahnbundesamt [8])

Table 3.5.2-3: Geometry data for source height B: 4m (eq. 3.8, eq. 3.10 and eq. 3:11) (Source: Eisenbahnbundesamt [8])

Coordinates Place of Immision			Geometry			
x (m)	y (m)	z (m)	phi (°)	Δ $L_{W,dir,hor,B}$ (dB)	Psi (°)	Δ $L_{W,dir,vert,B}$ db(A)
25	0	-50	59,036	-1,320	-61,635	-6,465
25	0	-47,5	59,036	-1,320	-60,485	-6,149
25	0	-45	59,036	-1,320	-59,248	-5,826
25	0	-42,5	59,036	-1,320	-57,913	-5,495
25	0	-40	59,036	-1,320	-56,471	-5,156
25	0	-37,5	59,036	-1,320	-54,911	-4,809
25	0	-35	59,036	-1,320	-53,220	-4,455
25	0	-32,5	59,036	-1,320	-51,384	-4,095
25	0	-30	59,036	-1,320	-49,387	-3,729
25	0	-27,5	59,036	-1,320	-47,214	-3,359
25	0	-25	59,036	-1,320	-44,848	-2,987
25	0	-22,5	59,036	-1,320	-42,269	-2,615
25	0	-20	59,036	-1,320	-39,461	-2,247
25	0	-17,5	59,036	-1,320	-36,407	-1,886
25	0	-15	59,036	-1,320	-33,092	-1,537
25	0	-12,5	59,036	-1,320	-29,507	-1,207
25	0	-10	59,036	-1,320	-25,650	-0,901
25	0	-7,5	59,036	-1,320	-21,527	-0,628
25	0	-5	59,036	-1,320	-17,155	-0,395
25	0	-2,5	59,036	-1,320	-12,568	-0,211
25	0	0	59,036	-1,320	-7,812	-0,081
25	0	2,5	59,036	-1,320	-2,945	-0,011
25	0	5	59,036	-1,320	1,964	0,000
25	0	7,5	59,036	-1,320	6,846	0,000
25	0	10	59,036	-1,320	11,629	0,000
25	0	12,5	59,036	-1,320	16,254	0,000
25	0	15	59,036	-1,320	20,671	0,000
25	0	17,5	59,036	-1,320	24,846	0,000
25	0	20	59,036	-1,320	28,758	0,000
25	0	22,5	59,036	-1,320	32,397	0,000
25	0	25	59,036	-1,320	35,765	0,000
25	0	27,5	59,036	-1,320	38,870	0,000
25	0	30	59,036	-1,320	41,726	0,000
25	0	32,5	59,036	-1,320	44,349	0,000
25	0	35	59,036	-1,320	46,757	0,000
25	0	37,5	59,036	-1,320	48,967	0,000
25	0	40	59,036	-1,320	50,998	0,000
25	0	42,5	59,036	-1,320	52,865	0,000
25	0	45	59,036	-1,320	54,584	0,000
25	0	47,5	59,036	-1,320	56,169	0,000
25	0	50	59,036	-1,320	57,634	0,000

With the emission data for the source height A (0.5m) shown in the diagram Table 3.5.2-2 the following values result for the directional sound power.

Table 3.5.2-4: Directional sound power level per meter for source height A: 0.5m (eq. 3.4.) (Source: Eisenbahnbundesamt [8])

(Table is continued on next page)

Coordinates Place of Immision													
x (m)	y (m)	z (m)	50 Hz	63 Hz	80 Hz	100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz
25	0	-50	54,870	55,549	58,162	60,108	58,474	58,653	59,255	61,475	61,619	62,516	62,812
25	0	-47,5	55,044	55,727	58,343	60,294	58,665	58,851	59,461	61,689	61,845	62,755	63,065
25	0	-45	55,227	55,913	58,533	60,488	58,865	59,058	59,676	61,914	62,080	63,005	63,330
25	0	-42,5	55,418	56,106	58,731	60,691	59,073	59,274	59,900	62,148	62,326	63,265	63,605
25	0	-40	55,616	56,308	58,936	60,901	59,289	59,498	60,133	62,391	62,582	63,535	63,892
25	0	-37,5	55,820	56,515	59,148	61,118	59,512	59,729	60,373	62,641	62,845	63,814	64,187
25	0	-35	56,029	56,728	59,365	61,340	59,741	59,966	60,619	62,898	63,115	64,099	64,489
25	0	-32,5	56,241	56,943	59,585	61,565	59,972	60,206	60,868	63,158	63,388	64,388	64,795
25	0	-30	56,452	57,158	59,805	61,790	60,203	60,445	61,116	63,417	63,660	64,677	65,101
25	0	-27,5	56,659	57,368	60,019	62,010	60,429	60,679	61,360	63,671	63,927	64,959	65,400
25	0	-25	56,856	57,569	60,224	62,220	60,645	60,903	61,592	63,914	64,182	65,229	65,686
25	0	-22,5	57,038	57,754	60,413	62,413	60,843	61,109	61,806	64,136	64,416	65,477	65,949
25	0	-20	57,196	57,915	60,577	62,581	61,016	61,288	61,992	64,331	64,621	65,693	66,177
25	0	-17,5	57,322	58,043	60,708	62,715	61,154	61,431	62,140	64,486	64,783	65,865	66,360
25	0	-15	57,408	58,130	60,797	62,806	61,248	61,528	62,241	64,591	64,894	65,982	66,484
25	0	-12,5	57,445	58,168	60,836	62,846	61,288	61,570	62,285	64,637	64,942	66,033	66,538
25	0	-10	57,429	58,151	60,819	62,828	61,270	61,551	62,265	64,616	64,920	66,010	66,514
25	0	-7,5	57,356	58,077	60,744	62,751	61,191	61,469	62,180	64,527	64,827	65,912	66,409
25	0	-5	57,233	57,952	60,615	62,620	61,056	61,329	62,035	64,375	64,668	65,743	66,230
25	0	-2,5	57,068	57,784	60,444	62,445	60,876	61,143	61,841	64,173	64,455	65,518	65,992
25	0	0	56,879	57,592	60,248	62,244	60,670	60,929	61,619	63,941	64,211	65,260	65,719
25	0	2,5	56,994	57,709	60,368	62,366	60,795	61,059	61,754	64,083	64,360	65,417	65,885
25	0	5	57,171	57,889	60,551	62,554	60,988	61,259	61,962	64,300	64,588	65,658	66,141
25	0	7,5	57,313	58,033	60,698	62,704	61,143	61,420	62,129	64,474	64,771	65,852	66,346
25	0	10	57,406	58,128	60,795	62,804	61,246	61,526	62,239	64,589	64,892	65,980	66,481
25	0	12,5	57,445	58,168	60,836	62,846	61,288	61,570	62,285	64,637	64,942	66,033	66,538
25	0	15	57,429	58,152	60,819	62,829	61,271	61,552	62,266	64,617	64,921	66,011	66,514
25	0	17,5	57,362	58,083	60,750	62,757	61,197	61,476	62,187	64,534	64,835	65,920	66,417
25	0	20	57,251	57,970	60,634	62,639	61,076	61,350	62,056	64,398	64,691	65,768	66,257
25	0	22,5	57,105	57,821	60,482	62,483	60,916	61,184	61,884	64,218	64,502	65,568	66,045
25	0	25	56,931	57,645	60,302	62,299	60,727	60,988	61,680	64,006	64,279	65,331	65,794
25	0	27,5	56,739	57,450	60,103	62,095	60,517	60,770	61,454	63,770	64,031	65,069	65,517
25	0	30	56,535	57,243	59,891	61,879	60,294	60,540	61,215	63,520	63,768	64,791	65,222
25	0	32,5	56,325	57,029	59,673	61,655	60,065	60,302	60,967	63,262	63,497	64,504	64,918
25	0	35	56,113	56,814	59,453	61,430	59,833	60,062	60,718	63,002	63,224	64,215	64,611
25	0	37,5	55,903	56,600	59,235	61,206	59,603	59,823	60,471	62,743	62,952	63,927	64,307
25	0	40	55,697	56,390	59,021	60,987	59,378	59,590	60,228	62,490	62,686	63,646	64,009
25	0	42,5	55,496	56,186	58,812	60,774	59,159	59,363	59,992	62,244	62,428	63,372	63,719
25	0	45	55,303	55,989	58,611	60,568	58,947	59,143	59,765	62,006	62,178	63,107	63,439
25	0	47,5	55,117	55,800	58,418	60,371	58,744	58,933	59,546	61,778	61,938	62,853	63,170
25	0	50	54,939	55,619	58,233	60,181	58,549	58,731	59,336	61,559	61,708	62,610	62,912

Geometry

$L_{W',dir,A,f}$

630 Hz	800 Hz	1000 Hz	1250 Hz	1600 Hz	2000 Hz	2500 Hz	3150 Hz	4000 Hz	5000 Hz	6300 Hz	8000 Hz	10000 Hz
62,833	65,317	66,531	67,057	66,354	67,383	67,926	66,893	62,451	59,410	56,720	54,799	53,193
63,103	65,605	66,839	67,387	66,710	67,763	68,332	67,327	62,916	59,904	57,245	55,357	53,781
63,384	65,907	67,162	67,732	67,082	68,161	68,758	67,782	63,403	60,421	57,794	55,940	54,397
63,678	66,222	67,498	68,092	67,470	68,576	69,201	68,256	63,910	60,960	58,367	56,548	55,039
63,983	66,549	67,847	68,465	67,872	69,006	69,661	68,748	64,436	61,520	58,962	57,180	55,706
64,298	66,886	68,207	68,850	68,288	69,451	70,136	69,256	64,979	62,097	59,575	57,831	56,394
64,620	67,231	68,576	69,245	68,713	69,906	70,622	69,776	65,535	62,688	60,203	58,498	57,098
64,946	67,580	68,949	69,644	69,143	70,366	71,114	70,302	66,098	63,286	60,839	59,174	57,811
65,272	67,929	69,322	70,043	69,573	70,826	71,605	70,827	66,660	63,883	61,473	59,848	58,522
65,591	68,271	69,687	70,434	69,994	71,276	72,086	71,342	67,211	64,469	62,095	60,508	59,219
65,895	68,597	70,036	70,806	70,396	71,706	72,546	71,833	67,736	65,027	62,688	61,138	59,885
66,175	68,897	70,356	71,149	70,766	72,101	72,968	72,285	68,219	65,540	63,234	61,718	60,496
66,419	69,158	70,635	71,448	71,087	72,445	73,336	72,678	68,640	65,988	63,709	62,223	61,029
66,613	69,366	70,858	71,686	71,344	72,720	73,630	72,992	68,976	66,345	64,089	62,626	61,455
66,745	69,508	71,009	71,848	71,519	72,907	73,829	73,206	69,204	66,587	64,346	62,899	61,743
66,803	69,569	71,075	71,918	71,594	72,988	73,915	73,298	69,303	66,692	64,458	63,018	61,869
66,777	69,541	71,045	71,886	71,560	72,951	73,876	73,256	69,258	66,645	64,408	62,965	61,812
66,665	69,422	70,918	71,750	71,413	72,794	73,708	73,077	69,066	66,440	64,190	62,734	61,569
66,475	69,218	70,699	71,517	71,162	72,525	73,421	72,769	68,737	66,091	63,819	62,339	61,152
66,221	68,946	70,409	71,206	70,827	72,167	73,038	72,360	68,299	65,626	63,325	61,814	60,598
65,930	68,634	70,076	70,849	70,442	71,756	72,599	71,890	67,797	65,091	62,757	61,211	59,961
66,108	68,825	70,279	71,067	70,677	72,006	72,867	72,176	68,103	65,417	63,103	61,579	60,350
66,380	69,116	70,591	71,400	71,036	72,391	73,277	72,616	68,573	65,916	63,633	62,142	60,944
66,598	69,350	70,840	71,667	71,324	72,699	73,606	72,968	68,950	66,317	64,059	62,594	61,421
66,742	69,505	71,006	71,844	71,515	72,903	73,824	73,201	69,199	66,581	64,340	62,893	61,737
66,803	69,569	71,075	71,918	71,594	72,988	73,915	73,298	69,303	66,692	64,458	63,018	61,869
66,778	69,543	71,046	71,888	71,562	72,953	73,878	73,258	69,260	66,647	64,410	62,967	61,814
66,674	69,432	70,928	71,761	71,425	72,807	73,722	73,091	69,081	66,457	64,208	62,752	61,588
66,503	69,248	70,732	71,551	71,199	72,565	73,463	72,815	68,786	66,143	63,874	62,398	61,214
66,277	69,006	70,473	71,275	70,901	72,246	73,123	72,450	68,396	65,729	63,434	61,930	60,721
66,010	68,720	70,168	70,948	70,549	71,869	72,720	72,020	67,936	65,239	62,914	61,378	60,137
65,715	68,403	69,829	70,586	70,158	71,451	72,274	71,542	67,425	64,696	62,337	60,765	59,490
65,400	68,067	69,470	70,201	69,743	71,008	71,799	71,035	66,883	64,120	61,724	60,115	58,804
65,077	67,720	69,099	69,804	69,316	70,551	71,311	70,513	66,324	63,526	61,093	59,444	58,096
64,750	67,370	68,725	69,404	68,885	70,089	70,818	69,986	65,760	62,927	60,457	58,768	57,382
64,426	67,023	68,354	69,007	68,457	69,632	70,329	69,463	65,200	62,332	59,825	58,097	56,674
64,108	66,682	67,990	68,618	68,037	69,183	69,849	68,950	64,652	61,749	59,205	57,438	55,979
63,799	66,351	67,636	68,239	67,629	68,746	69,383	68,451	64,118	61,182	58,602	56,798	55,303
63,500	66,032	67,295	67,874	67,235	68,325	68,933	67,969	63,603	60,634	58,021	56,181	54,651
63,214	65,725	66,966	67,523	66,857	67,920	68,500	67,507	63,108	60,109	57,462	55,587	54,024
62,939	65,431	66,652	67,187	66,495	67,533	68,086	67,064	62,635	59,605	56,927	55,019	53,425

(Source: Eisenbahnbundesamt [8])

With the emission data for the source height B (4m) shown in the diagram Table 3.5.2-3 the following values result for the directional sound power.

Table 3.5.2-5: Directional sound power level per meter for source height B: 4m (eq. 3.4.) (Source: Eisenbahnbundesamt [8])

(Table is continued on next page)

Coordinates Place of Immision														
x (m)	y (m)	z (m)	50 Hz	63 Hz	80 Hz	100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz
25	0	-50	28,709	30,509	27,309	25,509	24,409	24,409	23,409	38,209	22,209	22,309	38,309
25	0	-47,5	28,709	30,509	27,309	25,509	24,409	24,409	23,409	38,209	22,209	22,309	38,309
25	0	-45	28,709	30,509	27,309	25,509	24,409	24,409	23,409	38,209	22,209	22,309	38,309
25	0	-42,5	28,709	30,509	27,309	25,509	24,409	24,409	23,409	38,209	22,209	22,309	38,309
25	0	-40	28,709	30,509	27,309	25,509	24,409	24,409	23,409	38,209	22,209	22,309	38,309
25	0	-37,5	28,709	30,509	27,309	25,509	24,409	24,409	23,409	38,209	22,209	22,309	38,309
25	0	-35	28,709	30,509	27,309	25,509	24,409	24,409	23,409	38,209	22,209	22,309	38,309
25	0	-32,5	28,709	30,509	27,309	25,509	24,409	24,409	23,409	38,209	22,209	22,309	38,309
25	0	-30	28,709	30,509	27,309	25,509	24,409	24,409	23,409	38,209	22,209	22,309	38,309
25	0	-27,5	28,709	30,509	27,309	25,509	24,409	24,409	23,409	38,209	22,209	22,309	38,309
25	0	-25	28,709	30,509	27,309	25,509	24,409	24,409	23,409	38,209	22,209	22,309	38,309
25	0	-22,5	28,709	30,509	27,309	25,509	24,409	24,409	23,409	38,209	22,209	22,309	38,309
25	0	-20	28,709	30,509	27,309	25,509	24,409	24,409	23,409	38,209	22,209	22,309	38,309
25	0	-17,5	28,709	30,509	27,309	25,509	24,409	24,409	23,409	38,209	22,209	22,309	38,309
25	0	-15	28,709	30,509	27,309	25,509	24,409	24,409	23,409	38,209	22,209	22,309	38,309
25	0	-12,5	28,709	30,509	27,309	25,509	24,409	24,409	23,409	38,209	22,209	22,309	38,309
25	0	-10	28,709	30,509	27,309	25,509	24,409	24,409	23,409	38,209	22,209	22,309	38,309
25	0	-7,5	28,709	30,509	27,309	25,509	24,409	24,409	23,409	38,209	22,209	22,309	38,309
25	0	-5	28,709	30,509	27,309	25,509	24,409	24,409	23,409	38,209	22,209	22,309	38,309
25	0	-2,5	28,709	30,509	27,309	25,509	24,409	24,409	23,409	38,209	22,209	22,309	38,309
25	0	0	28,709	30,509	27,309	25,509	24,409	24,409	23,409	38,209	22,209	22,309	38,309
25	0	2,5	28,709	30,509	27,309	25,509	24,409	24,409	23,409	38,209	22,209	22,309	38,309
25	0	5	28,709	30,509	27,309	25,509	24,409	24,409	23,409	38,209	22,209	22,309	38,309
25	0	7,5	28,709	30,509	27,309	25,509	24,409	24,409	23,409	38,209	22,209	22,309	38,309
25	0	10	28,709	30,509	27,309	25,509	24,409	24,409	23,409	38,209	22,209	22,309	38,309
25	0	12,5	28,709	30,509	27,309	25,509	24,409	24,409	23,409	38,209	22,209	22,309	38,309
25	0	15	28,709	30,509	27,309	25,509	24,409	24,409	23,409	38,209	22,209	22,309	38,309
25	0	17,5	28,709	30,509	27,309	25,509	24,409	24,409	23,409	38,209	22,209	22,309	38,309
25	0	20	28,709	30,509	27,309	25,509	24,409	24,409	23,409	38,209	22,209	22,309	38,309
25	0	22,5	28,709	30,509	27,309	25,509	24,409	24,409	23,409	38,209	22,209	22,309	38,309
25	0	25	28,709	30,509	27,309	25,509	24,409	24,409	23,409	38,209	22,209	22,309	38,309
25	0	27,5	28,709	30,509	27,309	25,509	24,409	24,409	23,409	38,209	22,209	22,309	38,309
25	0	30	28,709	30,509	27,309	25,509	24,409	24,409	23,409	38,209	22,209	22,309	38,309
25	0	32,5	28,709	30,509	27,309	25,509	24,409	24,409	23,409	38,209	22,209	22,309	38,309
25	0	35	28,709	30,509	27,309	25,509	24,409	24,409	23,409	38,209	22,209	22,309	38,309
25	0	37,5	28,709	30,509	27,309	25,509	24,409	24,409	23,409	38,209	22,209	22,309	38,309
25	0	40	28,709	30,509	27,309	25,509	24,409	24,409	23,409	38,209	22,209	22,309	38,309
25	0	42,5	28,709	30,509	27,309	25,509	24,409	24,409	23,409	38,209	22,209	22,309	38,309
25	0	45	28,709	30,509	27,309	25,509	24,409	24,409	23,409	38,209	22,209	22,309	38,309
25	0	47,5	28,709	30,509	27,309	25,509	24,409	24,409	23,409	38,209	22,209	22,309	38,309
25	0	50	28,709	30,509	27,309	25,509	24,409	24,409	23,409	38,209	22,209	22,309	38,309

Geometry													
$L_{W',dir,B,f}$													
	630 Hz	800 Hz	1000 Hz	1250 Hz	1600 Hz	2000 Hz	2500 Hz	3150 Hz	4000 Hz	5000 Hz	6300 Hz	8000 Hz	10000 Hz
	21,609	21,209	28,509	23,409	42,730	47,762	47,853	43,058	15,209	12,510	9,911	7,412	5,215
	21,609	21,209	28,509	23,409	43,039	48,076	48,168	43,372	15,209	12,510	9,911	7,412	5,215
	21,609	21,209	28,509	23,409	43,357	48,398	48,490	43,695	15,209	12,510	9,911	7,413	5,216
	21,609	21,209	28,509	23,409	43,682	48,728	48,821	44,025	15,209	12,510	9,911	7,413	5,217
	21,609	21,209	28,509	23,409	44,017	49,066	49,160	44,363	15,210	12,510	9,911	7,413	5,217
	21,609	21,209	28,509	23,409	44,358	49,412	49,506	44,709	15,210	12,510	9,911	7,413	5,218
	21,609	21,209	28,509	23,409	44,708	49,765	49,859	45,062	15,210	12,510	9,911	7,414	5,219
	21,609	21,209	28,509	23,409	45,064	50,124	50,219	45,422	15,210	12,510	9,912	7,414	5,219
	21,609	21,209	28,509	23,409	45,425	50,489	50,584	45,787	15,210	12,510	9,912	7,415	5,220
	21,609	21,209	28,509	23,409	45,792	50,858	50,954	46,156	15,210	12,511	9,912	7,415	5,221
	21,609	21,209	28,509	23,409	46,160	51,229	51,326	46,528	15,210	12,511	9,912	7,416	5,222
	21,609	21,209	28,509	23,409	46,529	51,601	51,697	46,899	15,210	12,511	9,913	7,416	5,224
	21,609	21,209	28,509	23,409	46,894	51,968	52,065	47,267	15,210	12,511	9,913	7,417	5,225
	21,609	21,209	28,509	23,409	47,253	52,329	52,426	47,628	15,210	12,511	9,913	7,418	5,226
	21,609	21,209	28,509	23,409	47,599	52,677	52,775	47,976	15,210	12,511	9,914	7,418	5,228
	21,609	21,209	28,509	23,409	47,928	53,007	53,105	48,306	15,210	12,512	9,914	7,419	5,229
	21,609	21,209	28,509	23,409	48,232	53,313	53,410	48,612	15,210	12,512	9,914	7,420	5,231
	21,609	21,209	28,509	23,409	48,503	53,585	53,683	48,885	15,210	12,512	9,915	7,421	5,232
	21,609	21,209	28,509	23,409	48,735	53,818	53,916	49,117	15,211	12,512	9,915	7,421	5,233
	21,609	21,209	28,509	23,409	48,919	54,002	54,100	49,302	15,211	12,512	9,915	7,422	5,234
	21,609	21,209	28,509	23,409	49,048	54,132	54,230	49,431	15,211	12,512	9,916	7,422	5,235
	21,609	21,209	28,509	23,409	49,117	54,201	54,299	49,501	15,211	12,512	9,916	7,422	5,236
	21,609	21,209	28,509	23,409	49,128	54,213	54,311	49,512	15,211	12,512	9,916	7,422	5,236
	21,609	21,209	28,509	23,409	49,128	54,213	54,311	49,512	15,211	12,512	9,916	7,422	5,236
	21,609	21,209	28,509	23,409	49,128	54,213	54,311	49,512	15,211	12,512	9,916	7,422	5,236
	21,609	21,209	28,509	23,409	49,128	54,213	54,311	49,512	15,211	12,512	9,916	7,422	5,236
	21,609	21,209	28,509	23,409	49,128	54,213	54,311	49,512	15,211	12,512	9,916	7,422	5,236
	21,609	21,209	28,509	23,409	49,128	54,213	54,311	49,512	15,211	12,512	9,916	7,422	5,236
	21,609	21,209	28,509	23,409	49,128	54,213	54,311	49,512	15,211	12,512	9,916	7,422	5,236
	21,609	21,209	28,509	23,409	49,128	54,213	54,311	49,512	15,211	12,512	9,916	7,422	5,236
	21,609	21,209	28,509	23,409	49,128	54,213	54,311	49,512	15,211	12,512	9,916	7,422	5,236
	21,609	21,209	28,509	23,409	49,128	54,213	54,311	49,512	15,211	12,512	9,916	7,422	5,236
	21,609	21,209	28,509	23,409	49,128	54,213	54,311	49,512	15,211	12,512	9,916	7,422	5,236
	21,609	21,209	28,509	23,409	49,128	54,213	54,311	49,512	15,211	12,512	9,916	7,422	5,236
	21,609	21,209	28,509	23,409	49,128	54,213	54,311	49,512	15,211	12,512	9,916	7,422	5,236
	21,609	21,209	28,509	23,409	49,128	54,213	54,311	49,512	15,211	12,512	9,916	7,422	5,236
	21,609	21,209	28,509	23,409	49,128	54,213	54,311	49,512	15,211	12,512	9,916	7,422	5,236
	21,609	21,209	28,509	23,409	49,128	54,213	54,311	49,512	15,211	12,512	9,916	7,422	5,236
	21,609	21,209	28,509	23,409	49,128	54,213	54,311	49,512	15,211	12,512	9,916	7,422	5,236
	21,609	21,209	28,509	23,409	49,128	54,213	54,311	49,512	15,211	12,512	9,916	7,422	5,236
	21,609	21,209	28,509	23,409	49,128	54,213	54,311	49,512	15,211	12,512	9,916	7,422	5,236

(Source: Eisenbahnbundesamt [8])

For the dispersion calculation, the emission data shown in Table 3.5.2-4 and Table 3.5.2-5 are summarized in octaves.

Table 3.5.2-6: Directional sound power level per meter for source heights A and B are summarized in octaves (eq. 3.4.) (Source: Eisenbahnbundesamt [8])

(Table is continued on next page)

Coordinates Place of Immision			$L_{W',dir,A,f}$							
x (m)	y (m)	z (m)	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
25	0	-50	61,208	63,913	65,680	67,494	71,132	72,040	68,763	59,914
25	0	-47,5	61,387	64,104	65,897	67,748	71,444	72,424	69,211	60,463
25	0	-45	61,574	64,304	66,124	68,014	71,770	72,826	69,681	61,037
25	0	-42,5	61,769	64,512	66,360	68,291	72,110	73,245	70,171	61,636
25	0	-40	61,971	64,728	66,606	68,579	72,463	73,679	70,679	62,258
25	0	-37,5	62,180	64,951	66,859	68,876	72,827	74,128	71,204	62,899
25	0	-35	62,394	65,180	67,119	69,179	73,200	74,588	71,741	63,557
25	0	-32,5	62,611	65,411	67,382	69,487	73,578	75,053	72,285	64,223
25	0	-30	62,828	65,642	67,643	69,795	73,955	75,518	72,828	64,887
25	0	-27,5	63,039	65,868	67,900	70,096	74,325	75,973	73,361	65,538
25	0	-25	63,241	66,084	68,146	70,383	74,678	76,409	73,869	66,160
25	0	-22,5	63,427	66,282	68,371	70,648	75,002	76,809	74,336	66,732
25	0	-20	63,589	66,455	68,568	70,878	75,285	77,157	74,743	67,230
25	0	-17,5	63,718	66,593	68,724	71,062	75,511	77,435	75,069	67,629
25	0	-15	63,806	66,686	68,831	71,186	75,664	77,624	75,290	67,898
25	0	-12,5	63,844	66,727	68,877	71,241	75,731	77,706	75,385	68,016
25	0	-10	63,827	66,709	68,856	71,216	75,700	77,669	75,342	67,963
25	0	-7,5	63,753	66,630	68,766	71,111	75,571	77,510	75,156	67,735
25	0	-5	63,627	66,495	68,613	70,931	75,350	77,238	74,837	67,345
25	0	-2,5	63,458	66,315	68,408	70,691	75,056	76,875	74,414	66,827
25	0	0	63,265	66,109	68,173	70,416	74,718	76,459	73,928	66,232
25	0	2,5	63,383	66,234	68,317	70,584	74,925	76,713	74,224	66,595
25	0	5	63,563	66,427	68,536	70,841	75,240	77,101	74,679	67,151
25	0	7,5	63,708	66,582	68,712	71,047	75,493	77,413	75,043	67,597
25	0	10	63,804	66,684	68,829	71,184	75,661	77,620	75,285	67,892
25	0	12,5	63,844	66,727	68,877	71,241	75,731	77,706	75,385	68,016
25	0	15	63,828	66,710	68,857	71,217	75,702	77,671	75,344	67,965
25	0	17,5	63,759	66,636	68,773	71,119	75,582	77,523	75,171	67,753
25	0	20	63,645	66,515	68,635	70,958	75,383	77,278	74,885	67,403
25	0	22,5	63,495	66,354	68,453	70,744	75,121	76,955	74,507	66,942
25	0	25	63,318	66,165	68,239	70,492	74,812	76,574	74,062	66,396
25	0	27,5	63,121	65,955	68,000	70,213	74,469	76,151	73,568	65,792
25	0	30	62,913	65,733	67,747	69,916	74,105	75,702	73,043	65,150
25	0	32,5	62,698	65,503	67,486	69,611	73,729	75,240	72,503	64,489
25	0	35	62,481	65,272	67,224	69,302	73,351	74,773	71,958	63,822
25	0	37,5	62,266	65,042	66,962	68,996	72,975	74,311	71,417	63,161
25	0	40	62,055	64,817	66,706	68,697	72,607	73,857	70,887	62,512
25	0	42,5	61,849	64,598	66,458	68,405	72,249	73,416	70,372	61,882
25	0	45	61,651	64,386	66,218	68,123	71,904	72,991	69,874	61,274
25	0	47,5	61,461	64,183	65,987	67,853	71,572	72,582	69,397	60,689
25	0	50	61,278	63,988	65,766	67,594	71,255	72,192	68,940	60,130

$L_{W',dir,B,f}$							
63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
33,812	29,579	38,455	38,506	30,256	51,445	43,069	12,702
33,812	29,579	38,455	38,506	30,256	51,759	43,382	12,702
33,812	29,579	38,455	38,506	30,256	52,080	43,704	12,703
33,812	29,579	38,455	38,506	30,256	52,410	44,034	12,703
33,812	29,579	38,455	38,506	30,256	52,748	44,371	12,703
33,812	29,579	38,455	38,506	30,256	53,093	44,716	12,703
33,812	29,579	38,455	38,506	30,256	53,446	45,069	12,704
33,812	29,579	38,455	38,506	30,256	53,805	45,428	12,704
33,812	29,579	38,455	38,506	30,256	54,169	45,793	12,705
33,812	29,579	38,455	38,506	30,256	54,539	46,161	12,705
33,812	29,579	38,455	38,506	30,256	54,910	46,533	12,705
33,812	29,579	38,455	38,506	30,256	55,281	46,904	12,706
33,812	29,579	38,455	38,506	30,256	55,648	47,271	12,707
33,812	29,579	38,455	38,506	30,256	56,009	47,632	12,707
33,812	29,579	38,455	38,506	30,256	56,357	47,980	12,708
33,812	29,579	38,455	38,506	30,256	56,687	48,309	12,708
33,812	29,579	38,455	38,506	30,256	56,992	48,615	12,709
33,812	29,579	38,455	38,506	30,256	57,264	48,888	12,710
33,812	29,579	38,455	38,506	30,256	57,497	49,120	12,710
33,812	29,579	38,455	38,506	30,256	57,681	49,305	12,711
33,812	29,579	38,455	38,506	30,256	57,811	49,434	12,711
33,812	29,579	38,455	38,506	30,256	57,880	49,503	12,712
33,812	29,579	38,455	38,506	30,256	57,892	49,514	12,712
33,812	29,579	38,455	38,506	30,256	57,892	49,514	12,712
33,812	29,579	38,455	38,506	30,256	57,892	49,514	12,712
33,812	29,579	38,455	38,506	30,256	57,892	49,514	12,712
33,812	29,579	38,455	38,506	30,256	57,892	49,514	12,712
33,812	29,579	38,455	38,506	30,256	57,892	49,514	12,712
33,812	29,579	38,455	38,506	30,256	57,892	49,514	12,712
33,812	29,579	38,455	38,506	30,256	57,892	49,514	12,712
33,812	29,579	38,455	38,506	30,256	57,892	49,514	12,712
33,812	29,579	38,455	38,506	30,256	57,892	49,514	12,712
33,812	29,579	38,455	38,506	30,256	57,892	49,514	12,712
33,812	29,579	38,455	38,506	30,256	57,892	49,514	12,712
33,812	29,579	38,455	38,506	30,256	57,892	49,514	12,712
33,812	29,579	38,455	38,506	30,256	57,892	49,514	12,712
33,812	29,579	38,455	38,506	30,256	57,892	49,514	12,712
33,812	29,579	38,455	38,506	30,256	57,892	49,514	12,712
33,812	29,579	38,455	38,506	30,256	57,892	49,514	12,712
33,812	29,579	38,455	38,506	30,256	57,892	49,514	12,712
33,812	29,579	38,455	38,506	30,256	57,892	49,514	12,712

(Source: Eisenbahnbundesamt [8])

4 Test scenarios for BUB, noise emission industry

4.1 Purpose

The calculation of emissions from industrial installations shall be carried out in accordance with [2] and [5]).

The set of test cases documented in this chapter includes the part Industrial and Commercial Noise according to section 4 of Appendix 1 of the Methods for Calculating Environmental Noise from Ground-level Sources (Roads, Railways, Industry and Commerce) (BUB) [2].

4.2 Preliminary remarks

In the case of the test cases for industrial emissions, the cases TC_I 1 and TC_I 2 require a precise determination (to 3 digits after the decimal point), while the cases TC_I 3 and TC_I 4 require ±0.1 dB - as with the test cases for dispersion (Chapter 5 Dispersion). For TC_I 5, an accuracy of ±0.5 dB must be allowed, as the procedure (for the directional characteristic) in the specification leaves some leeway for implementation.

4.3 Test Cases

4.3.1 TC_I 1: Rail yard - Conversion of an area-related sound power level into the sound power level of a point source

<u>Input data</u>

- Rail yard

Table 4.3.1-1: Geometry, Rail yard (Source: Umweltbundesamt [9])

	X in m	Y in m	Z in m
1	0	0	0
2	1500	0	0
3	2000	300	0
4	5000	300	0
5	5500	0	0
6	7000	0	0
7	7000	-100	0
8	5500	-100	0
9	5000	-400	0
10	2000	-400	0
11	1500	-100	0
12	0	-100	0

Area-related sound power levels for rail yards from Table C-1 [5].

Based on the geometry data, conversion of the area-related sound power levels into sound power levels of a point source.

Results

Table 4.3.1-2: Sound power level for rail yard (Source: Umweltbundesamt [9])

Octave midband frequency (Hz)		63	125	250	500	1000	2000	4000	8000
Rail yard	$L_{w,f}$	131.47	129.37	125.97	122.47	124.47	123.57	123.57	120.07

4.3.2 TC_I 2: Transshipment station - Conversion of an area-related sound power level into the sound power level of a point source

Input data

- Transshipment station

Table 4.3.2-1: Geometry, transshipment station (Source: Umweltbundesamt [9])

	X in m	Y in m	Z in m
1	0	0	0
2	500	300	0
3	3500	300	0
4	4000	0	0

Area-related sound power levels for transshipment stations from Table C-1 [5].

Based on the geometry data, conversion of the area-related sound power levels into sound power levels of a point source.

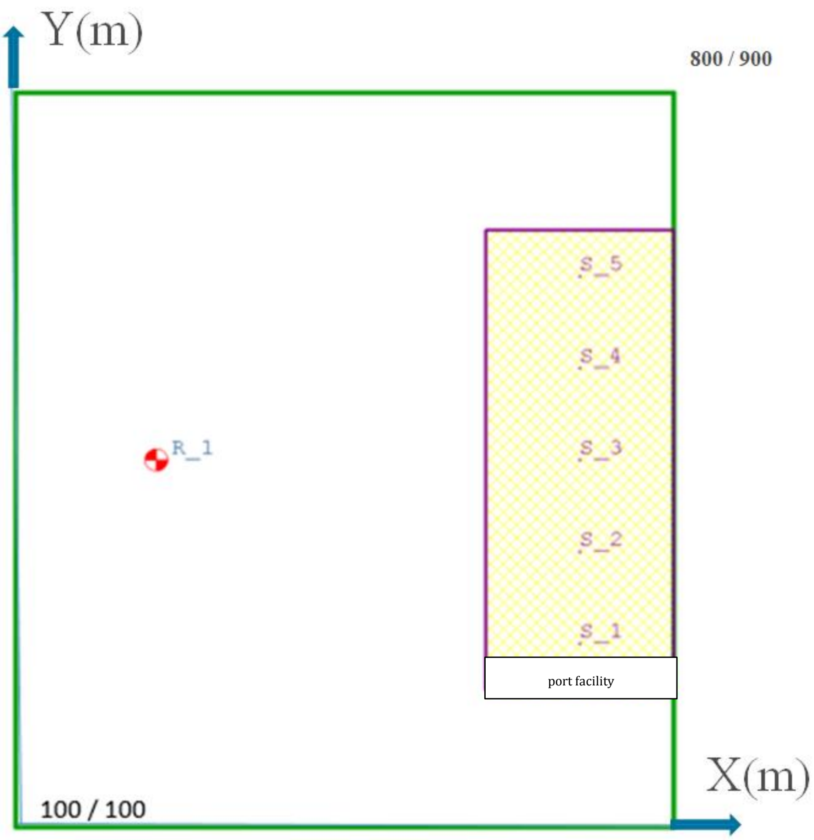
Results

Table 4.3.2-2: Sound power level for the transshipment station (Source: Umweltbundesamt [9])

Octave band center frequency (Hz)		63	125	250	500	1000	2000	4000	8000
Transship-ment station	$L_{w,f}$	126.61	123.11	124.51	121.71	122.01	119.21	111.41	107.81

4.3.3 TC_I 3 - Evaluation times of a static area source

Figure 4.3.3-1: Free sound propagation over level ground (S source, R immission point) (Source: Umweltbundesamt [9])



Scenario-related considerations:

- The 5 replacement point sound sources shown are a permissible specification at the given distance to the receptor, which could also be arranged differently according to the 0.5 distance criterion. Any finer subdivision of the area source is generally permissible. The 5 substitute sources each represent 20,000 m^2, which corresponds to a conversion term of 43.01 dB.
- The emission values for the area source "ports" are declared as hemispherical values.

  (according to Table C-1 from [5]).

Input data:

Floor	Soundproof, G = 0
Area source	Octave spectrum "ports" as area-related sound power level (Table 5.3.26-12)
Height for receptor	4 m
Height for sources	4 m
Operating time	06:00 bis 23:00, i.e. time correction for the night from 10lg(1/8)=-9,03dB
Night appraisal time	(22.00 to 06.00)
Meteorology	Tailwind

Table 4.3.3-1: Octave spectrum "Ports" (taken from Table C-1 [5]) "Lw" as sound power per square meter for area sources as a function of frequency (Source: Umweltbundesamt [9])

Descrip-tion	Source type	Directivity of source	63	125	250	500	1000	2000	4000	8000
Ports	Area source	semi-sphere	58.0	58.0	58.0	58.0	58.0	58.0	58.0	58.0

Table 4.3.3-2: X,Y Coordinates of the area source, the substitute sources and the immission point R (all coordinates in m) (Source: Umweltbundesamt [9])

Object	X	Y	X	Y	X	Y	X	Y
Floor, G=0	100	100	800	100	800	900	100	900
Area source	600	250	800	250	800	750	600	750
Substitute source S_1	700	300						
Substitute source S_2	700	400						
Substitute source S_3	700	500						
Substitute source S_4	700	600						
Substitute source S_5	700	700						
Receptor	250	500						

Table 4.3.3-3: Spectral intermediate and final results Source S_1 for the night (100% fav.) (Source: Umweltbundesamt [9])

f in Hz	63	125	250	500	1000	2000	4000	8000	Total
L_W“ in dB	58.0	58.0	58.0	58.0	58.00	58.0	58.0	58.0	
L_W in dB	101.01	101.01	101.01	101.01	101.01	101.01	101.01	101.01	
α_{atm}	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.06	0.20	0.51	0.95	1.80	4.76	16.14	57.56	
A_{div} in dB	64.85	64.85	64.85	64.85	64.85	64.85	64.85	64.85	
$A_{boundary,F}$ in dB	-6.08	-6.08	-6.08	-6.08	-6.08	-6.08	-6.08	-6.08	
L_F in dB	42.18	42.04	41.73	41.29	40.44	37.48	26.10	-15.32	48.92
A-weighting in dB	-26.2	-16.1	-8.6	-3.2	0.0	1.2	1.0	-1.1	
L_{FA} in dB	15.98	25.94	33.13	38.09	40.44	38.68	27.10	-16.42	44.45
Correction for time	-9.03	-9.03	-9.03	-9.03	-9.03	-9.03	-9.03	-9.03	
L_{Ar} in dB	6.95	16.91	24.10	29.06	31.41	29.65	18.07	-25.45	35.42

Table 4.3.3-4: Spectral intermediate and final results Source S_2 for the night (100% fav.) (Source: Umweltbundesamt [9])

f in Hz	63	125	250	500	1000	2000	4000	8000	Total
L_W" in dB	58.0	58.0	58.0	58.0	58.00	58.0	58.0	58.0	
L_W in dB	101.01	101.01	101.01	101.01	101.01	101.01	101.01	101.01	
α_{atm}	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.06	0.19	0.48	0.89	1.69	4.45	15.11	53.88	
A_{div} in dB	64.27	64.27	64.27	64.27	64.27	64.27	64.27	64.27	
$A_{boundary,F}$ in dB	-5.88	-5.88	-5.88	-5.88	-5.88	-5.88	-5.88	-5.88	
L_F in dB	42.56	42.42	42.13	41.72	40.93	38.16	27.51	-11.27	49.35
A-weighting in dB	-26.2	-16.1	-8.6	-3.2	0.0	1.2	1.0	-1.1	
L_{FA} in dB	16.36	26.32	33.53	38.52	40.93	39.36	28.51	-12.37	44.99
Correction for time	-9.03	-9.03	-9.03	-9.03	-9.03	-9.03	-9.03	-9.03	
L_{Ar} in dB	7.33	17.29	24.50	29.49	31.90	30.33	19.48	-21.40	35.96

Table 4.3.3-5: Spectral intermediate and final results Source S_3 for the night (100% fav.) (Source: Umweltbundesamt [9])

f in Hz	63	125	250	500	1000	2000	4000	8000	Total
L_W" in dB	58.0	58.0	58.0	58.0	58.00	58.0	58.0	58.0	
L_W in dB	101.01	101.01	101.01	101.01	101.01	101.01	101.01	101.01	
α_{atm}	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.05	0.18	0.47	0.87	1.65	4.35	14.75	52.60	
A_{div} in dB	64.06	64.06	64.06	64.06	64.06	64.06	64.06	64.06	
$A_{boundary,F}$ in dB	-5.80	-5.80	-5.80	-5.80	-5.80	-5.80	-5.80	-5.80	
L_F in dB	42.69	42.56	42.28	41.88	41.10	38.40	28.00	-9.85	49.51
A-weighting in dB	-26.2	-16.1	-8.6	-3.2	0.0	1.2	1.0	-1.1	
L_{FA} in dB	16.49	26.46	33.68	38.68	41.10	39.60	29.00	-10.95	45.18
Correction for time	-9.03	-9.03	-9.03	-9.03	-9.03	-9.03	-9.03	-9.03	
L_{Ar} in dB	7.46	17.43	24.65	29.65	32.07	30.57	19.97	-19.98	36.15

Table 4.3.3-6: Result L_{Ar} per replacement source and total result for the night (100% fav.) (Source: Umweltbundesamt [9])

f in Hz	63	125	250	500	1000	2000	4000	8000	Total
S_1	6.95	16.91	24.10	29.06	31.41	29.65	18.07	-25.45	35.42
S_2	7.33	17.29	24.50	29.49	31.90	30.33	19.48	-21.40	35.96
S_3	7.46	17.43	24.65	29.65	32.07	30.57	19.97	-19.98	36.15
S_4	7.33	17.29	24.50	29.49	31.90	30.33	19.48	-21.40	35.96
S_5	6.95	16.91	24.10	29.06	31.41	29.65	18.07	-25.45	35.42
Sum	14.20	24.16	31.37	36.35	38.73	37.11	26.07	-15.19	42.78

4.3.4 TC_I 4 - Evaluation times of a moving source

Basic model	TC 01 (Chapter 5.3.2)
Emission per octave band (L_w)	93 dB
Specification for the operating time:	continuous operation during the day
Type of operation:	2 vehicles travel at 20 km/h per hour along a 20 m route
Speed (v)	20 km/h

The correction terms (in dB) for deriving a sound power level per meter (L_w‘) from the available data is determined according to equation 4.1 from [2].

C_W = -10 lg (l*N/(1000 * V)
C_W = -10 lg (2*20/(1000 * 20)) = 26,99 dB

At the distance between S and R given in TC 01 (Chapter 5.3.2), a 20 m long line source can be represented by a point source at point S, with the sound power set at:

$L_w + C_W$ = (93 +26,99) dB

The obtained immission values are derived from the results of TC 01 (Chapter 5.3.2) according to Table 5.3.26-18.

Table 4.3.4-1: Immission values (in dB(A)) (Source: Umweltbundesamt [9])

f in Hz	63	125	250	500	1000	2000	4000	8000	Total
Lr day	40.74	50.78	58.16	63.39	66.25	66.28	61.60	43.16	71.11

4.3.5 TC_I 5 - Directivity (2-D)

Scenario-related considerations
For the point source, a 2-D directivity with discrete values in 30 degree intervals between 0 and 360 degrees is assumed. The directivity for any direction is determined by linear interpolation. The values of the directivity correction are energetically 0-normalized (5.3.27-1) in relation to the table values in order not to change the emission level in total. This is achieved with equidistant grid points if the energetic sum of the correction values for n grid points divided by the number of grid points results in the value 1.

With separate geometry (part 2), the source-related definition of the reference direction and the invariance of the 2-d directivity against different Z heights of the receptor position are tested.

Basic model, Part 1	TC 16 (Chapter 5.3.17)
Emission per octave band (L_w)	93 dB
Specification for the operating time:	continuous operation during the day
Reference direction of the source:	0,-1,0 (negative Y-direction)
Angle of directivity	from reference direction in mathematically positive direction of rotation (counterclockwise)

Table 4.3.5-1: Directivity (Source: Umweltbundesamt [9])

	Angle (degrees) from reference direction											
	0	30	60	90	120	150	180	210	240	270	300	330
Correction of directivity	1.95	1.95	1.05	-0.85	-2.05	-2.05	-2.05	-2.05	-2.05	-0.85	1.05	1.95

Table 4.3.5-2: Location of source and receptor positions (Source: Umweltbundesamt [9])

	X	Y	angles against X
Source	10.00	10.00	
Receptor	200.00	50.00	
Angle S-R			11.9
Reflection point	131.86	54.55	
Angle S-R‘			20.1

Taking into account the reference direction of the source
the receptor lies at an angle of 90 + 11,9 = 101,9 (degrees)
and the mirror point of the receptor at 90 + 20,1 = 110,1 (degrees)

Determination of the directivity corrections by interpolation provides

- for the direct component
  -0,85 + (-2,05+0,85) /(120-90)* (101,9-90) = -1,33 (dB)
- for the reflected component
  -0,85 + (-2,05+0,85) /(120-90)* (110,1-90) = -1,65 (dB)

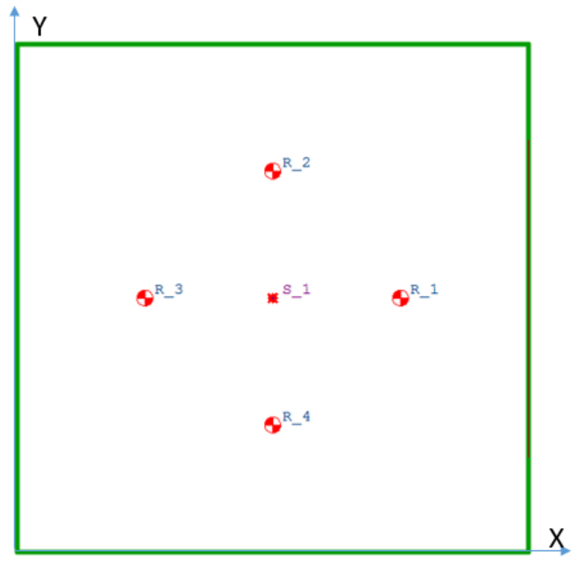
The immission values from TC 16 (Chapter 5.3.17) change as shown in Table 5.3.27-1.

Table 4.3.5-3: Immission values taking into account the directivity (Source: Umweltbundesamt [9])

f in Hz	63	125	250	500	1000	2000	4000	8000	Total
L_A in dB direct sound	9.73	19.78	27.15	32.38	35.24	35.28	30.58	12.11	40.10
L_A in dB reflection	8.45	18.31	25.10	29.66	31.72	30.76	24.72	8.15	36.34
L_A in dB	12.15	22.12	29.26	34.24	36.84	36.59	31.58	13.58	41.62

Figure4.3.5-1 shows the model geometry of the 2nd part of the test case.

Figure4.3.5-1: Arrangement source S and immission locations R (Source: Umweltbundesamt [9])



Input data:

Floor	Soundproof, G = 0, level terrain
Point source	L_W = 100 dB per cctave
Orientation	The reference direction of the directivity is the positive x-direction
Directivity	Correction of directivity (acc. to Table 4.3.5.1)

Table 4.3.5-4: X,Y Coordinates of source S and points of immission R (Source: Umweltbundesamt [9])

Object	X	Y	Z
Source S_1	500	500	20
Receptor R_1	700	500	10
Receptor R_2	500	700	20
Receptor R_3	300	500	30
Receptor R_4	500	300	20

Table 4.3.5-5: Proportion of directivity to total immission value (in dB(A)) (Source: Umweltbundesamt [9])

	L_A (dB) without directivity	L_A (dB) with directivity	Directivity (dB)
R_1	47.09	49.04	1.95
R_2	47.07	46.99	-0.85
R_3	47.05	45.00	-2.05
R_4	47.07	46.22	-0.85

5 Test scenarios for BUB, sound propagation

5.1 Purpose

The calculation of the sound propagation shall be carried out within the framework of the Environmental Noise Directive according to Regulation 2015/996 of the EU Commission of 19 May 2015, taking into account the national adaptation ([2] to [6]). These test cases serve to evaluate the reproduction of the above by a program and were created in accordance with DIN 45687 "Acoustics - Software products for the calculation of noise immission outdoors - Quality requirements and test specifications", May 2006 [11]. This set of test cases includes the part on sound propagation according to section 5 of Appendix 1 of the Methods for Calculating Ambient Noise from Ground-level Sources (Roads, Railways, Industry and Trade) (BUB) [2].

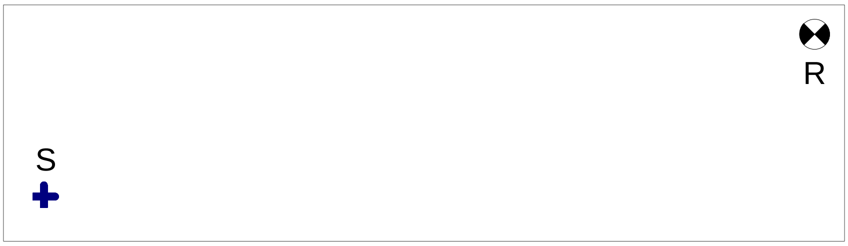
5.2 Preliminary remarks

For the test cases for sound propagation, an accuracy requirement of ±0.1 dB is derived on the basis of the possible result scatter.

5.3 Test Cases

5.3.1 TC 01 - TC 03 - Level floor with uniform acoustic properties (G constant)

Figure 5.3.1-1: Free sound propagation over level ground (S source, R immission point) (Source: Umweltbundesamt [9])



With the first three test cases the correct consideration of the ground factor G is checked. It is a level terrain with a source and a receiver. The ground factors 0, 0,5 and 1 apply to the ground.

Table 5.3.1-1: Coordinates of source S and point of immission R (Source: Umweltbundesamt [9])

Point	x (m)	y (m)	z (abs) (m)
S	10	10	1
R	200	50	4

Table 5.3.1-2: Meteorological and geometrical parameters (Source: Umweltbundesamt [9])

p %	50	**Ground elevation (m)**	0
rF %	70	**G**	0
T °C	10		
Gs	0		

Table 5.3.1-3: Unweighted octave band - Sound power level (Source: Umweltbundesamt [9])

Octave band center frequency (Hz)							
63	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
93	93	93	93	93	93	93	93

Table 5.3.1-4: Mean ground levels MGL and average ground factors (Hom) (Source: Umweltbundesamt [9])

Parameters	S -> R
a (MGL)	0.00
b (MGL)	0.00
z1	1.00
z2	4.00
dp	194.16
Gpath	0.00
G'path	0.00

5.3.2 TC 01 - Reflecting ground (G = 0)

Table 5.3.2-1: Ground attenuation (relevant if no diffraction) (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000
w (H)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C_f (H)	194.16	194.16	194.16	194.16	194.16	194.16	194.16	194.16
$A_{ground,H}$	**-3.00**	**-3.00**	**-3.00**	**-3.00**	**-3.00**	**-3.00**	**-3.00**	**-3.00**
w (F)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C_f (F)	194.16	194.16	194.16	194.16	194.16	194.16	194.16	194.16
$A_{ground,F}$	**-4.36**	**-4.36**	**-4.36**	**-4.36**	**-4.36**	**-4.36**	**-4.36**	**-4.36**

Table 5.3.2-2: Spectral intermediate and final results for the vertical propagation plane (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	
L_W in dB	93	93	93	93	93	93	93	93	
α_{atm}	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.02	0.08	0.20	0.37	0.71	1.88	6.36	22.70	
A_{div} in dB	56.76	56.76	56.76	56.76	56.76	56.76	56.76	56.76	
$A_{boundary,H}$ in dB	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	
$A_{boundary,F}$ in dB	-4.36	-4.36	-4.36	-4.36	-4.36	-4.36	-4.36	-4.36	**Total**
L_H in dB	39.21	39.16	39.03	38.86	38.53	37.36	32.87	16.54	46.70
L_F in dB	40.58	40.52	40.40	40.23	39.89	38.72	34.24	17.90	48.07
L in dB	39.95	39.89	39.77	39.60	39.26	38.09	33.61	17.27	47.44
A-weighting dB	-26.2	-16.1	-8.6	-3.2	0.0	1.2	1.0	-1.1	
L_A^a in dB	**13.75**	**23.79**	**31.17**	**36.40**	**39.26**	**39.29**	**34.61**	**16.17**	**44.12**

5.3.3 TC 02 - Grounds with mixed acoustic properties (G = 0.5)

Table 5.3.3-1: Meteorological and geometrical parameters (Source: Umweltbundesamt [9])

p %	50	**Ground height (m)**	0
rF %	70	**G**	0.5
T °C	10		
Gs	0.5		

Table 5.3.3-2: Ground attenuation (relevant if no diffraction) (Source: Umweltbundesamt [9])

Frequency (Hz)-->	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
w (H)	8,2E-05	4,5E-04	2,5E-03	0.01	0.08	0.41	2.10	10.13
C_f (H)	199.17	213.44	225.43	134.05	23.76	2.49	0.47	0.10
$A_{ground,H}$	**-1.50**	**-1.50**	**-1.50**	**0.85**	**5.71**	**-1.50**	**-1.50**	**-1.50**
w (F)	0.00	0.00	0.00	0.01	0.08	0.41	2.10	10.13
C_f (F)	199.17	213.44	225.43	134.05	23.76	2.49	0.47	0.10
$A_{ground,F}$	**-2.18**	**-2.18**	**-2.18**	**-2.18**	**-0.93**	**-2.18**	**-2.18**	**-2.18**

Table 5.3.3-3: Spectral intermediate and final results for the vertical propagation plane (Source: Umweltbundesamt [9])

Frequency (Hz)-->	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	
L_W in dB	93	93	93	93	93	93	93	93	
α_{atm}	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.02	0.08	0.20	0.37	0.71	1.88	6.36	22.70	
A_{div} in dB	56.76	56.76	56.76	56.76	56.76	56.76	56.76	56.76	
$A_{boundary,H}$ in dB	-1.50	-1.50	-1.50	0.85	5.71	-1.50	-1.50	-1.50	
$A_{boundary,F}$ in dB	-2.18	-2.18	-2.18	-2.18	-0.93	-2.18	-2.18	-2.18	**Total**
L_H in dB	37.71	37.66	37.53	35.01	29.82	35.86	31.37	15.04	44.28
L_F in dB	38.39	38.34	38.22	38.04	36.45	36.54	32.05	15.72	45.72
L in dB	38.07	38.01	37.89	36.79	34.29	36.21	31.73	15.39	45.06
A-weighting dB	-26.2	-16.1	-8.6	-3.2	0.0	1.2	1.0	-1.1	
$L_A{}^a$ in dB	**11.87**	**21.91**	**29.29**	**33.59**	**34.29**	**37.41**	**32.73**	**14.29**	**41.27**

5.3.4 TC 03 - Porous ground (G = 1)

Table 5.3.4-1: Meteorological and geometrical parameters (Source: Umweltbundesamt [9])

p %	50	**Ground height (m)**	0
rF %	70	**G**	1
T °C	10		
Gs	1		

Table 5.3.4-2: Ground attenuation (relevant if no diffraction) (Source: Umweltbundesamt [9])

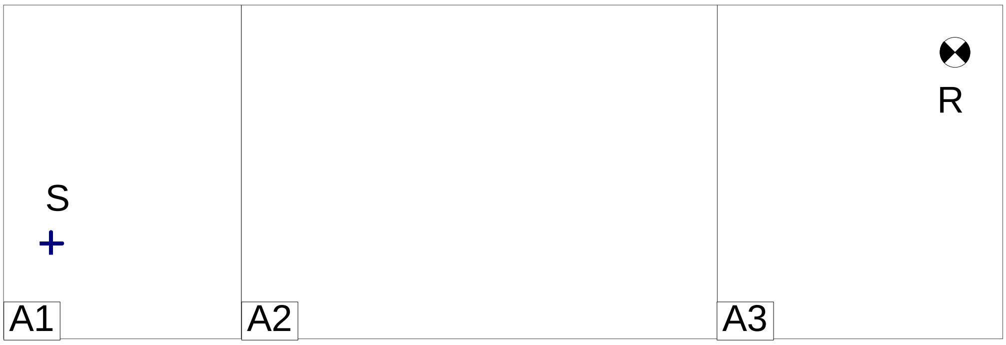
Frequency (Hz)-->	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
w (H)	4,9E-04	2,7E-03	1,5E-02	0.08	0.41	2.02	9.06	35.59
C_f (H)	214.47	224.67	130.15	22.76	2.48	0.49	0.11	0.03
$A_{ground,H}$	**0.00**	**0.00**	**1.59**	**9.67**	**5.03**	**0.00**	**0.00**	**0.00**
w (F)	0.00	0.00	0.01	0.08	0.41	2.02	9.06	35.59
C_f (F)	214.47	224.67	130.15	22.76	2.48	0.49	0.11	0.03
$A_{ground,F}$	**0.00**	**0.00**	**0.00**	**4.23**	**0.00**	**0.00**	**0.00**	**0.00**

Table 5.3.4-3: Spectral intermediate and final results for the vertical propagation plane (Source: Umweltbundesamt [9])

Frequency (Hz)-->	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	
L_W in dB	93	93	93	93	93	93	93	93	
α_{atm}	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.02	0.08	0.20	0.37	0.71	1.88	6.36	22.70	
A_{div} in dB	56.76	56.76	56.76	56.76	56.76	56.76	56.76	56.76	
$A_{boundary,H}$ in dB	0.00	0.00	1.59	9.67	5.03	0.00	0.00	0.00	
$A_{boundary,F}$ in dB	0.00	0.00	0.00	4.23	0.00	0.00	0.00	0.00	**Total**
L_H in dB	36.21	36.16	34.45	26.19	30.49	34.36	29.87	13.54	42.14
L_F in dB	36.21	36.16	36.03	31.63	35.53	34.36	29.87	13.54	43.24
L in dB	36.21	36.16	35.31	29.71	33.70	34.36	29.87	13.54	42.72
A-weighting dB	-26.2	-16.1	-8.6	-3.2	0.0	1.2	1.0	-1.1	
$L_A{}^a$ in dB	**10.01**	**20.06**	**26.71**	**26.51**	**33.70**	**35.56**	**30.87**	**12.44**	**39.14**

5.3.5 TC 04 - Level ground with varying ground factor G

Figure 5.3.5-1: Scenario with level ground but varying acoustic properties (S source, R point of immission, A1 area with G=0.2, A2 area with G=0.5, A3 area with G=0.9) (Source: Umweltbundesamt [9])



This test case refers to the correct averaging of the ground factors G.

Table 5.3.5-1: Rectangular areas with a given ground index G (Source: Umweltbundesamt [9])

G	x (m)		y (m)	
	min	max	min	max
0.2	0.00	50.00	-20.00	70.00
0.5	50.00	150.00	-20.00	70.00
0.9	150.00	210.00	-20.00	70.00

Table 5.3.5-2: G-profile on the propagation path (Source: Umweltbundesamt [9])

G-Profil S -> R			
from (m)	to (m)	length (m)	G
0.00	40.88	40.88	0.2
40.88	143.07	102.19	0.5
143.07	194.16	51.09	0.9

Table 5.3.5-3: Ground attenuation (relevant if no diffraction) (Source: Umweltbundesamt [9])

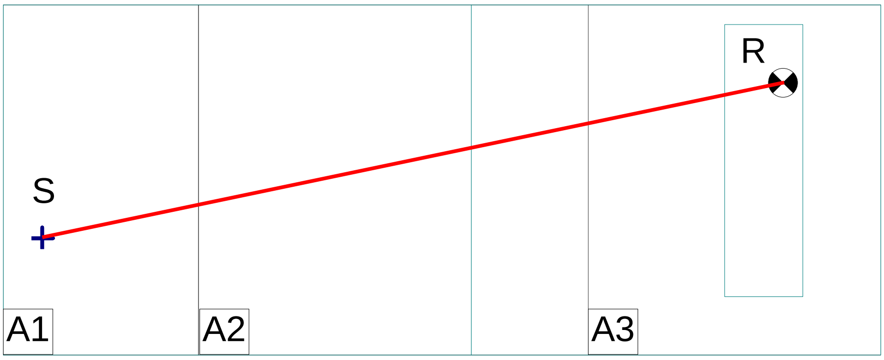
Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000
w (H)	1,0E-04	5,6E-04	3,1E-03	0.02	0.09	0.50	2.53	11.96
C_f (H)	200.18	216.12	221.91	116.87	17.87	2.02	0.39	0.08
$A_{ground,H}$	**-1.37**	**-1.37**	**-1.37**	**1.77**	**6.23**	**-1.37**	**-1.37**	**-1.37**
w (F)	0.00	0.00	0.00	0.02	0.09	0.50	2.53	11.96
C_f (F)	200.18	216.12	221.91	116.87	17.87	2.02	0.39	0.08
$A_{ground,F}$	**-2.00**	**-2.00**	**-2.00**	**-2.00**	**-0.95**	**-2.00**	**-2.00**	**-2.00**

Table 5.3.5-4: Spectral intermediate and final results for the vertical propagation plane (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	Total
L_W in dB	93	93	93	93	93	93	93	93	
α_{atm}	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.02	0.08	0.20	0.37	0.71	1.88	6.36	22.70	
A_{div} in dB	56.76	56.76	56.76	56.76	56.76	56.76	56.76	56.76	
$A_{boundary,H}$ in dB	-1.37	-1.37	-1.37	1.77	6.23	-1.37	-1.37	-1.37	
$A_{boundary,F}$ in dB	-2.00	-2.00	-2.00	-2.00	-0.95	-2.00	-2.00	-2.00	
L_H in dB	37.59	37.53	37.41	34.10	29.29	35.73	31.25	14.91	44.05
L_F in dB	38.21	38.15	38.03	37.86	36.48	36.36	31.87	15.54	45.56
L in dB	37.91	37.85	37.73	36.37	34.23	36.06	31.57	15.24	44.87
A-weighting dB	-26.2	-16.1	-8.6	-3.2	0.0	1.2	1.0	-1.1	
$L_A{}^a$ in dB	**11.71**	**21.75**	**29.13**	**33.17**	**34.23**	**37.26**	**32.57**	**14.14**	**41.09**

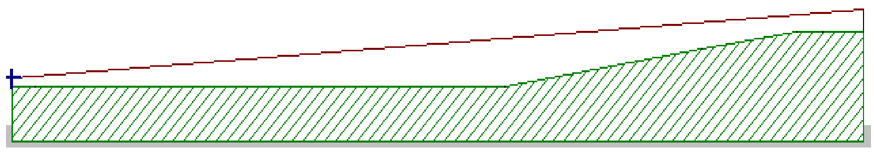
5.3.6 TC 05 - Ground with varying heights and with areas of varying ground factor G

Figure 5.3.6-1: Scenario with different heights and acoustic properties of the ground (S source, R place of immission, A1 area with G=0.9, A2 area with G=0.5, A3 area with G=0.2) (Source: Umweltbundesamt [9])



Altitude of the point of immission R: 14 m absolute (4 m relative)

Figure 5.3.6-2: Cut from S to R with beam S->R (Source: Umweltbundesamt [9])



With TC 05, varying ground factors G and varying ground heights are included. However, due to the height of the beam S->R above the ground edge, there is no diffraction yet.

Table 5.3.6-1: Coordinates of source S and point of immission R (Source: Umweltbundesamt [9])

Point	x (m)	y (m)	z (abs) (m)
S	10	10	1
R	200	50	14

Table 5.3.6-2: Contour lines to describe the ground model (Source: Umweltbundesamt [9])

No.	x1 (m)	y1 (m)	z1 (m)	x2 (m)	y2 (m)	z2 (m)
1	185	-5	10	205	-5	10
2	205	-5	10	205	65	10
3	205	65	10	185	65	10
4	185	65	10	185	-5	10

Table 5.3.6-3: Rectangular areas with a given ground index G (Source: Umweltbundesamt [9])

G	x (m)		y (m)	
	min	**max**	**min**	**max**
0.9	0.00	50.00	-20.00	70.00
0.5	50.00	150.00	-20.00	70.00
0.2	150.00	225.00	-20.00	70.00

Table 5.3.6-4: Mean ground levels MGL and average ground factors (Hom) (Source: Umweltbundesamt [9])

Parameters	S -> R
a (MGL)	0.05
b (MGL)	-2.83
z1	3.83
z2	6.16
dp	194.59
Gpath	0.51
G'path	0.64

Table 5.3.6-5: Ground attenuation (relevant if no diffraction) (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000
w (H)	1,6E-04	8,7E-04	4,8E-03	0.03	0.14	0.75	3.70	16.77
C_f (H)	203.37	222.35	207.73	82.09	9.63	1.33	0.27	0.06
$A_{ground,H}$	**-1.07**	**-1.07**	**-1.07**	**-1.07**	**-1.07**	**-1.07**	**-1.07**	**-1.07**
w (F)	0.00	0.00	0.00	0.01	0.08	0.42	2.16	10.35
C_f (F)	199.73	214.27	225.54	131.93	22.89	2.42	0.46	0.10
$A_{ground,F}$	**-1.07**	**-1.07**	**-1.07**	**-1.07**	**-1.07**	**-1.07**	**-1.07**	**-1.07**

Table 5.3.6-6: Spectral intermediate and final results for the vertical propagation plane (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	
L_W in dB	93	93	93	93	93	93	93	93	
α_{atm}	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.02	0.08	0.20	0.38	0.71	1.88	6.38	22.75	
A_{div} in dB	56.78	56.78	56.78	56.78	56.78	56.78	56.78	56.78	
$A_{boundary,H}$ in dB	-1.07	-1.07	-1.07	-1.07	-1.07	-1.07	-1.07	-1.07	
$A_{boundary,F}$ in dB	-1.07	-1.07	-1.07	-1.07	-1.07	-1.07	-1.07	-1.07	**Total**
L_H in dB	37.26	37.21	37.08	36.91	36.57	35.41	30.91	14.54	44.75
L_F in dB	37.26	37.21	37.08	36.91	36.57	35.41	30.91	14.54	44.75
L in dB	37.26	37.21	37.08	36.91	36.57	35.41	30.91	14.54	44.75
A-weighting dB	-26.2	-16.1	-8.6	-3.2	0.0	1.2	1.0	-1.1	
L_A^a in dB	**11.06**	**21.11**	**28.48**	**33.71**	**36.57**	**36.61**	**31.91**	**13.44**	**41.43**

5.3.7 TC 06 - With diffraction/sound barrier in some frequency bands

Scenario as before, but altitude of the point of immission R: 11.5 m absolute (1.5 m relative). This lower beam height above the ground edge results in screening of otherwise homogeneous propagation conditions in some frequency bands. With this scenario the different diffraction conditions for homogeneous and favorable propagation conditions as well as the correct application of the Rayleigh Criterion are tested.

Figure 5.3.7-1: Cut from S to R with beam S->R (Source: Umweltbundesamt [9])

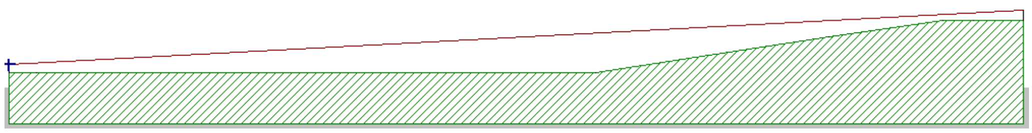


Table 5.3.7-1: Ground attenuation (relevant if no diffraction) (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000
w (H)	1,1E-04	6,0E-04	3,4E-03	-	-	0.53	2.70	12.70
C_f (H)	200.89	217.45	220.41	-	-	1.88	0.37	0.08
$A_{ground,H}$	**-1.32**	**-1.32**	**-1.32**	**-**	**-**	**-1.32**	**-1.32**	**-1.32**
w (F)	0.00	0.00	0.00	0.01	0.08	0.42	2.16	10.35
C_f (F)	199.59	214.11	225.39	131.90	22.89	2.42	0.46	0.10
$A_{ground,F}$	**-1.32**	**-1.32**	**-1.29**	**-1.05**	**-1.32**	**-1.32**	**-1.32**	**-1.32**

Table 5.3.7-2: z-height profile along the propagation path (Source: Umweltbundesamt [9])

z-Profile S - R		
No.	u (m)	v (m)
1	0.00	0.00
2	112.41	0.00
3	178.84	10.00
4	194.16	10.00

Table 5.3.7-3: Mean ground levels MGL and average ground factors (Hom) (Source: Umweltbundesamt [9])

Parameters	S -> R
a (MGL)	0.05
b (MGL)	-2.83
z1	3.83
z2	3.66
dp	194.45
Gpath	0.51
G'path	0.56

Table 5.3.7-4: Coordinates of the mirror points (Hom) (Source: Umweltbundesamt [9])

Mirror points	u	v
S' (S -> O)	0.31	-5.65
R' (O -> R)	194.16	8.50

Table 5.3.7-5: Detour calculation due to sound barriers (Source: Umweltbundesamt [9])

Parameters	S -> R		S '-> R		S -> R'	
	Hom	Fav	Hom	Fav	Hom	Fav
KA1	3	3	3	-	3	-
KA2	3	3	3	-	3	-
dir	194.45	194.58	194.61	-	194.31	-
dss	179.06	179.16	179.21	-	179.06	-
dsr	15.40	15.40	15.40	-	15.40	-
e	0.00	0.00	0.00	-	0.00	-
z	-0.02	-0.04	0.00	-	0.15	-

Table 5.3.7-6: Sound barrier values for testing the Rayleigh Criterion (Source: Umweltbundesamt [9])

Parameters	Hom			Fav		
	63	125	250	63	125	250
KA	3	3	3.00	3.00	3.00	3.00
$-\lambda/20$	-0.27	-0.136	-0.07	-0.27	-0.14	-0.07
S-R	194.45	194.45	194.45	194.58	194.58	194.58
dss (S-D-R)	179.06	179.06	179.06	179.16	179.16	179.16
dsr (S-D-R)	15.40	15.40	15.402	15.40	15.40	15.40
δ_D	-0.016	-0.016	-0.016	-0.04	-0.04	-0.04
$\delta_D > -\lambda/20$?	+	+	+	+	+	+
S*-R*	194.37	194.37	194.37	194.5	194.49565	194.49565
dss (S*-D-R*)	179.21	179.21	179.21	179.31	179.30844	179.30844
dsr (S*-D-R*)	15.40	15.40	15.402	15.402	15.402075	15.402075
δ_D*	0.242	0.242	0.2422	0.2149	0.214859	0.214859
$\lambda/4-\delta_D$*	1.107	0.4378	0.0978	1.1343	0.465141	0.125141
$\delta_D > (\lambda/4 - \delta D^*)$?	-	-	-	-	-	-
R-Criterion fulfilled?	-	-	-	-	-	-

Table 5.3.7-7: Calculation of A boundary (Hom) (Source: Umweltbundesamt [9])

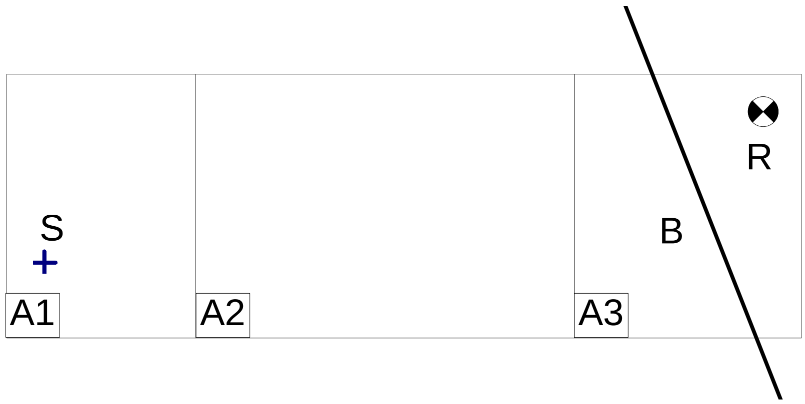
Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000
$\Delta_{dif(S,R)}$	0.00	0.00	0.00	3.16	0.56	0.00	0.00	0.00
$A_{ground,(S,O)}$	-	-	-	2.74	-1.21	-	-	-
$A_{ground,(O,R)}$	-	-	-	-2.40	-2.40	-	-	-
$\Delta_{dif(S',R)}$	-	-	-	4.71	4.65	-	-	-
$\Delta_{dif(S,R')}$	-	-	-	10.83	13.26	-	-	-
$\Delta_{ground(S,O)}$	-	-	-	2.23	-0.77	-	-	-
$\Delta_{ground(O,R)}$	-	-	-	-1.07	-0.62	-	-	-
A_{dif}	-	-	-	4.31	-0.83	-	-	-
$A_{ground(S,R)}$	-1.32	-1.32	-1.32	-	-	-1.32	-1.32	-1.32
$A_{boundary,H}$	**-1.32**	**-1.32**	**-1.32**	**4.31**	**-0.83**	**-1.32**	**-1.32**	**-1.32**

Table 5.3.7-8: Spectral intermediate and final results for the vertical propagation plane (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	
L_W in dB	93	93	93	93	93	93	93	93	
α_{atm}	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.02	0.08	0.20	0.37	0.71	1.88	6.37	22.73	
A_{div} in dB	56.78	56.78	56.78	56.78	56.78	56.78	56.78	56.78	
$A_{boundary,H}$ in dB	-1.32	-1.32	-1.32	4.31	-0.83	-1.32	-1.32	-1.32	
$A_{boundary,F}$ in dB	-1.32	-1.32	-1.29	-1.05	-1.32	-1.32	-1.32	-1.32	**Total**
L_H in dB	37.53	37.47	37.35	31.54	36.34	35.67	31.18	14.82	44.38
L_F in dB	37.53	37.47	37.31	36.89	36.84	35.67	31.18	14.82	44.97
L in dB	37.53	37.47	37.33	34.99	36.60	35.67	31.18	14.82	44.68
A-weighting dB	-26.2	-16.1	-8.6	-3.2	0.0	1.2	1.0	-1.1	
$L_A{}^a$ in dB	**11.33**	**21.37**	**28.73**	**31.79**	**36.60**	**36.87**	**32.18**	**13.72**	**41.31**

5.3.8 TC 07 - Level ground with varying ground factor G and long noise barrier

Figure 5.3.8-1: Long noise barrier on level ground with varying acoustic properties (S source, R immission point, B noise barrier, A1 area with G=0.2, A2 area with G=0.5, A3 area with G=0.9) (Source: Umweltbundesamt [9])



Checking the diffraction calculation and in particular the different detours past the sound barrier for the two propagation conditions.

Table 5.3.8-1: Coordinates of sound barriers (upper edge) (Source: Umweltbundesamt [9])

Barrier No.	x (m)	y (m)	z (m)
1	100.00	240.00	6.00
1	265.00	-180.00	6.00

Table 5.3.8-2: z-height profile along the propagation path (Source: Umweltbundesamt [9])

z-Profile S – R		
No.	u (m)	v (m)
1	0.00	0.00
2	170.23	0.00
3	170.23	6.00
4	170.23	0.00
5	194.16	0.00

Table 5.3.8-3: Coordinates of the mirror points (Hom) (Source: Umweltbundesamt [9])

Mirror points	u	v
S' (S -> O)	0.00	-1.00
R' (O -> R)	194.16	-4.00

Table 5.3.8-4: Mean ground levels MGL and average ground factors (Hom) (Source: Umweltbundesamt [9])

Parameters	S -> O1	On -> R
a (MGL)	0.00	0.00
b (MGL)	0.00	0.00
z1	1.00	6.00
z2	6.00	4.00
dp	170.23	23.93
Gpath	0.55	0.20
G'path	0.61	

Table 5.3.8-5: Detour calculation due to sound barriers (Source: Umweltbundesamt [9])

Para-meters	S -> R		S '-> R		S -> R'		Lateral right		Lateral left	
	Hom	Fav	Hom	Fav	Hom	Fav	Hom	Fav	Hom	Fav
KA1	3	3	3	3	3	3				
KA2	3	3	3	3	3	3				
dir	194.19	194.31	194.23	194.36	194.23	194.36				
dss	170.30	170.39	170.38	170.46	170.30	170.39				
dsr	24.02	24.02	24.02	24.02	25.94	25.94				
e	0.00	0.00	0.00	0.00	0.00	0.00				
z	0.13	0.09	0.16	0.12	2.01	1.97				

Table 5.3.8-6: Calculation of A boundary (Hom) (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000
$\Delta_{dif(S,R)}$	6.01	6.96	8.41	10.36	12.72	15.37	18.19	21.10
$A_{ground,(S,O)}$	-1.16	-1.16	-1.16	-1.16	1.45	-1.16	-1.16	-1.16
$A_{ground,(O,R)}$	-2.40	-2.40	-2.40	-2.40	-2.40	-2.40	-2.40	-2.40
$\Delta_{dif(S',R)}$	6.24	7.32	8.92	11.00	13.46	16.16	19.01	21.94
$\Delta_{dif(S,R')}$	12.54	15.13	17.94	20.85	23.80	26.78	29.78	32.78
$\Delta_{ground(S,O)}$	-1.13	-1.11	-1.09	-1.08	1.32	-1.06	-1.06	-1.06
$\Delta_{ground(O,R)}$	-1.22	-1.02	-0.88	-0.79	-0.74	-0.71	-0.70	-0.69
A_{dif}	3.67	4.83	6.44	8.49	13.30	13.60	16.43	19.35
$A_{ground(S,R)}$	-	-	-	-	-	-	-	-
$A_{boundary,H}$	**3.67**	**4.83**	**6.44**	**8.49**	**13.30**	**13.60**	**16.43**	**19.35**

Table 5.3.8-7: Calculation of A boundary (Fav) (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000
$\Delta_{dif(S,R)}$	5.67	6.40	7.58	9.27	11.43	13.94	16.68	19.55
$A_{ground,(S,O)}$	-1.16	-1.16	-1.16	-1.16	-1.16	-1.16	-1.16	-1.16
$A_{ground,(O,R)}$	-2.40	-2.40	-2.40	-2.40	-2.40	-2.40	-2.40	-2.40
$\Delta_{dif(S',R)}$	5.91	6.81	8.19	10.07	12.39	15.01	17.81	20.71
$\Delta_{dif(S,R')}$	12.46	15.05	17.86	20.76	23.71	26.70	29.69	32.70
$\Delta_{ground(S,O)}$	-1.12	-1.11	-1.08	-1.06	-1.04	-1.03	-1.02	-1.02
$\Delta_{ground(O,R)}$	-1.18	-0.96	-0.81	-0.71	-0.65	-0.61	-0.60	-0.59
A_{dif}	3.36	4.33	5.69	7.50	9.74	12.30	15.06	17.94
$A_{ground(S,R)}$	-	-	-	-	-	-	-	-
$A_{boundary,H}$	**3.36**	**4.33**	**5.69**	**7.50**	**9.74**	**12.30**	**15.06**	**17.94**

Table 5.3.8-8: Spectral intermediate and final results for the vertical propagation plane (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	
L_W in dB	93	93	93	93	93	93	93	93	
α_{atm}	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.02	0.08	0.20	0.37	0.71	1.88	6.36	22.70	
A_{div} in dB	56.76	56.76	56.76	56.76	56.76	56.76	56.76	56.76	
$A_{boundary,H}$ in dB	3.67	4.83	6.44	8.49	13.30	13.60	16.43	19.35	
$A_{boundary,F}$ in dB	3.36	4.33	5.69	7.50	9.74	12.30	15.06	17.94	**Total**
L_H in dB	32.54	31.32	29.60	27.37	22.22	20.76	13.44	-5.81	36.92
L_F in dB	32.85	31.83	30.35	28.36	25.78	22.06	14.81	-4.41	37.63
L in dB	32.70	31.58	29.99	27.89	24.36	21.46	14.18	-5.05	37.29
A-weighting dB	-26.2	-16.1	-8.6	-3.2	0.0	1.2	1.0	-1.1	
$L_A{}^a$ in dB	**6.50**	**15.48**	**21.39**	**24.69**	**24.36**	**22.66**	**15.18**	**-6.15**	**29.83**

5.3.9 TC 08 - Level ground with varying ground factor G and short noise barrier (with side diffraction)

This test case is much more complex than with ISO 9613-2 due to the side diffraction to be considered according to BUB, because here the side detours are considered as independent propagation paths.

Figure 5.3.9-1: Short noise barrier on level ground with varying acoustic properties (S source, R immission point, B noise barrier, A1 area with G=0.2, A2 area with G=0.5, A3 area with G=0.9) (Source: Umweltbundesamt [9])

Table 5.3.9-1: Coordinates of sound barriers (upper edge) (Source: Umweltbundesamt [9])

Barrier No.	x (m)	y (m)	z (m)
1	175.00	50.00	6.00
1	188.00	34.00	6.00

Table 5.3.9-2: z-height profile along the propagation path (Source: Umweltbundesamt [9])

z-Profile S - R		
No.	u (m)	v (m)
1	0.00	0.00
2	172.35	0.00
3	172.35	6.00
4	172.35	0.00
5	194.16	0.00

Table 5.3.9-3: Coordinates of the mirror points (Hom) (Source: Umweltbundesamt [9])

Mirror points	u	v
S' (S -> O)	0.00	-1.00
R' (O -> R)	194.16	-4.00

Table 5.3.9-4: Mean ground levels MGL and average ground factors (Hom) (Source: Umweltbundesamt [9])

Parameters	S -> R	S -> O1	On -> R	S->R ri	S->R le
a (MGL)	-	0.00	0.00	0.00	0.00
b (MGL)	-	0.00	0.00	0.00	0.00
z1	-	1.00	6.00	1.00	1.00
z2	-	6.00	4.00	4.00	4.00
dp	-	172.35	21.82	199.61	194.78
Gpath	-	0.54	0.20	0.49	0.51
G'path	-	0.61		0.49	0.51

Table 5.3.9-5: Detour calculation due to sound barriers (Source: Umweltbundesamt [9])

Para-meters	S -> R		S '-> R		S -> R'		Lateral right		Lateral left	
	Hom	Fav	Hom	Fav	Hom	Fav	Hom	Fav	Hom	Fav
KA1	3	3	3	3	3	3	-	-	-	-
KA2	3	3	3	3	3	3	-	-	-	-
dir	194.188	194.315	194.229	194.356	194.229	194.356	194.188	194.188	194.188	194.188
dss	172.421	172.510	172.491	172.579	172.421	172.510	179.631	179.631	169.800	169.800
dsr	21.908	21.908	21.908	21.908	23.999	23.999	20.005	20.005	25.003	25.003
e	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
z	0.141	0.103	0.169	0.131	2.191	2.153	5.448	5.448	0.615	0.615

Table 5.3.9-6: Calculation of A boundary (Hom) (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000
$\Delta_{dif(S,R)}$	6.07	7.05	8.54	10.52	12.91	15.58	18.40	21.32
$A_{ground,(S,O)}$	-1.18	-1.18	-1.18	-1.18	1.54	-1.18	-1.18	-1.18
$A_{ground,(O,R)}$	-2.40	-2.40	-2.40	-2.40	-2.40	-2.40	-2.40	-2.40
$\Delta_{dif(S',R)}$	6.29	7.39	9.02	11.12	13.60	16.32	19.17	22.10
$\Delta_{dif(S,R')}$	12.84	15.47	18.29	21.20	24.16	27.15	30.15	33.15
$\Delta_{ground(S,O)}$	-1.15	-1.13	-1.12	-1.10	1.42	-1.09	-1.08	-1.08
$\Delta_{ground(O,R)}$	-1.18	-0.99	-0.86	-0.77	-0.73	-0.70	-0.69	-0.68
A_{dif}	3.74	4.93	6.56	8.65	13.60	13.79	16.63	19.56
$A_{ground(S,R)}$	-	-	-	-	-	-	-	-
$A_{boundary,H}$	**3.74**	**4.93**	**6.56**	**8.65**	**13.60**	**13.79**	**16.63**	**19.56**

Table 5.3.9-7: Calculation of A boundary (Fav) (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000
$\Delta_{dif(S,R)}$	5.76	6.55	7.80	9.57	11.79	14.35	17.11	20.00
$A_{ground,(S,O)}$	-1.18	-1.18	-1.18	-1.18	-1.18	-1.18	-1.18	-1.18
$A_{ground,(O,R)}$	-2.40	-2.40	-2.40	-2.40	-2.40	-2.40	-2.40	-2.40
$\Delta_{dif(S',R)}$	5.99	6.93	8.37	10.31	12.66	15.30	18.12	21.03
$\Delta_{dif(S,R')}$	12.78	15.40	18.22	21.13	24.09	27.07	30.07	33.07
$\Delta_{ground(S,O)}$	-1.15	-1.13	-1.11	-1.09	-1.07	-1.06	-1.06	-1.05
$\Delta_{ground(O,R)}$	-1.15	-0.94	-0.80	-0.70	-0.65	-0.62	-0.60	-0.59
A_{dif}	3.46	4.47	5.90	7.78	10.08	12.67	15.46	18.35
$A_{ground(S,R)}$	-	-	-	-	-	-	-	-
$A_{boundary,H}$	**3.46**	**4.47**	**5.90**	**7.78**	**10.08**	**12.67**	**15.46**	**18.35**

Table 5.3.9-8: Spectral intermediate and final results for the vertical propagation plane (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	
L_W in dB	93	93	93	93	93	93	93	93	
α_{atm}	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.02	0.08	0.20	0.37	0.71	1.88	6.36	22.70	
A_{div} in dB	56.76	56.76	56.76	56.76	56.76	56.76	56.76	56.76	
$A_{boundary,H}$ in dB	3.74	4.93	6.56	8.65	13.60	13.79	16.63	19.56	
$A_{boundary,F}$ in dB	3.46	4.47	5.90	7.78	10.08	12.67	15.46	18.35	**Total**
L_H in dB	32.48	31.23	29.47	27.21	21.92	20.57	13.24	-6.02	36.81
L_F in dB	32.76	31.68	30.13	28.08	25.45	21.69	14.41	-4.81	37.45
L in dB	32.62	31.46	29.81	27.67	24.03	21.16	13.87	-5.37	37.14
A-weighting dB	-26.2	-16.1	-8.6	-3.2	0.0	1.2	1.0	-1.1	
$L_A{}^a$ in dB	**6.42**	**15.36**	**21.21**	**24.47**	**24.03**	**22.36**	**14.87**	**-6.47**	**29.58**

Table 5.3.9-9: Ground attenuation for lateral propagation (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000
lateral right								
w hom	0.00	0.00	0.00	0.01	0.07	0.40	2.04	9.84
Cf hom	204.72	219.33	231.84	138.42	24.64	2.57	0.49	0.10
A ground-right hom	**-1.52**	**-1.52**	**-1.52**	**0.87**	**5.86**	**-1.44**	**-1.52**	**-1.52**
w fav	0.00	0.00	0.00	0.01	0.07	0.40	2.04	9.84
Cf fav	204.72	219.33	231.84	138.42	24.64	2.57	0.49	0.10
A ground-right fav	**-2.28**	**-2.28**	**-2.28**	**-2.28**	**-0.98**	**-2.28**	**-2.28**	**-2.28**
lateral left								
w hom	0.00	0.00	0.00	0.01	0.08	0.42	2.17	10.40
Cf hom	199.96	214.57	225.67	131.49	22.70	2.41	0.46	0.10
A ground- left hom	**-1.48**	**-1.48**	**-1.48**	**1.01**	**5.84**	**-1.48**	**-1.48**	**-1.48**
w fav	0.00	0.00	0.00	0.01	0.08	0.42	2.17	10.40
Cf fav	199.96	214.57	225.67	131.49	22.70	2.41	0.46	0.10
A ground- left Fav	**-2.16**	**-2.16**	**-2.16**	**-2.16**	**-0.92**	**-2.16**	**-2.16**	**-2.16**

Table 5.3.9-10: Calculation of the unweighted partial level for the right detour (Hom) (Source: Umweltbundesamt [9])

Lateral right H									
Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	
L_W in dB	93	93	93	93	93	93	93	93	
α-atm(10°,70%)	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.02	0.08	0.21	0.38	0.73	1.93	6.54	23.33	
A_{div} in dB	56.76	56.76	56.76	56.76	56.76	56.76	56.76	56.76	
$A_{ground,H}$ in dB	-1.52	-1.52	-1.52	0.87	5.86	-1.44	-1.52	-1.52	
$\Delta_{dif,H}$ in dB	16.37	19.20	22.13	25.10	28.09	31.09	34.09	37.10	
A_H in dB	71.64	74.52	77.58	83.12	91.44	88.35	95.88	115.68	**Total**
L_H in dB	**21.36**	**18.48**	**15.42**	**9.88**	**1.56**	**4.65**	**-2.88**	**-22.68**	**24.09**

Table 5.3.9-11: Calculation of the unweighted partial level for the right detour (Fav) (Source: Umweltbundesamt [9])

Lateral right F									
Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	
L_W in dB	93	93	93	93	93	93	93	93	
α-atm(10°,70%)	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.02	0.08	0.21	0.38	0.73	1.93	6.54	23.33	
A_{div} in dB	56.76	56.76	56.76	56.76	56.76	56.76	56.76	56.76	
$A_{ground,F}$ in dB	-2.28	-2.28	-2.28	-2.28	-0.98	-2.28	-2.28	-2.28	
$\Delta_{dif,F}$ in dB	16.37	19.20	22.13	25.10	28.09	31.09	34.09	37.10	
A_F in dB	70.89	73.77	76.82	79.97	84.60	87.51	95.12	114.92	**Total**
L_F in dB	**22.11**	**19.23**	**16.18**	**13.03**	**8.40**	**5.49**	**-2.12**	**-21.92**	**25.04**

Table 5.3.9-12: Calculation of the unweighted partial level for the left detour (Hom) (Source: Umweltbundesamt [9])

Lateral left H									
Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	
L_W in dB	93	93	93	93	93	93	93	93	
α-atm(10°,70%)	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.02	0.08	0.20	0.38	0.71	1.88	6.38	22.77	
A_{div} in dB	56.76	56.76	56.76	56.76	56.76	56.76	56.76	56.76	
$A_{ground,H}$ in dB	-1.48	-1.48	-1.48	1.01	5.84	-1.48	-1.48	-1.48	
$\Delta_{dif,H}$ in dB	8.79	10.81	13.24	15.93	18.77	21.70	24.66	27.65	
A_H in dB	64.09	66.17	68.73	74.08	82.09	78.86	86.33	105.70	**Total**
L_H in dB	**28.91**	**26.83**	**24.27**	**18.92**	**10.91**	**14.14**	**6.67**	**-12.70**	**32.17**

Table 5.3.9-13: Calculation of the unweighted partial level for the left detour (Fav) (Source: Umweltbundesamt [9])

Lateral left F									
Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	
L_W in dB	93	93	93	93	93	93	93	93	
α-atm(10°,70%)	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.02	0.08	0.20	0.38	0.71	1.88	6.38	22.77	
A_{div} in dB	56.76	56.76	56.76	56.76	56.76	56.76	56.76	56.76	
$A_{ground,F}$ in dB	-2.16	-2.16	-2.16	-2.16	-0.92	-2.16	-2.16	-2.16	
$\Delta_{dif,F}$ in dB	8.79	10.81	13.24	15.93	18.77	21.70	24.66	27.65	
A_F in dB	63.41	65.49	68.05	70.91	75.33	78.18	85.65	105.02	**Total**
L_F in dB	**29.59**	**27.51**	**24.95**	**22.09**	**17.67**	**14.82**	**7.35**	**-12.02**	**33.10**

Table 5.3.9-14: Partial and total levels for the three propagation paths (Source: Umweltbundesamt [9])

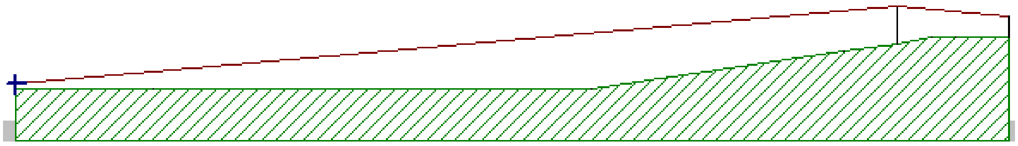
Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	
L_A in dB top	6.42	15.36	21.21	24.47	24.03	22.36	14.87	-6.47	
L_A in dB right	-4.45	2.77	7.21	8.53	6.20	6.29	-1.49	-23.39	
L_A in dB left	3.06	11.08	16.02	17.59	15.49	15.69	8.02	-13.45	**Total**
L_A in dB	**8.30**	**16.91**	**22.49**	**25.37**	**24.67**	**23.30**	**15.77**	**-5.61**	**30.50**

5.3.10 TC 09 - Ground with varying heights and ground factors G with short sound barrier (with side diffraction)

Figure 5.3.10-1: Short sound barrier on sloping ground (S source, R immission point, B sound barrier, A1 area with G=0.2, A2 area with G=0.5, A3 area with G=0.9) (Source: Umweltbundesamt [9])

Coordinates of source, point of immission and sound barrier as well as G-factors such as TC 08. Absolute sound barrier height 16 m.

Figure 5.3.10-2: Longitudinal section in vertical plane EV with beam path (Source: Umweltbundesamt [9])



By combining different G-factors and ground heights as well as the inclusion of diffraction over the sound barrier and around the two vertical edges, this test case checks all essential intermediate steps related to a single sound barrier.

Table 5.3.10-1: Contour lines to describe the ground model (Source: Umweltbundesamt [9])

No.	x1 (m)	y1 (m)	z1 (m)	x2 (m)	y2 (m)	z2 (m)
1	185	-5	10	205	-5	10
2	205	-5	10	205	65	10
3	205	65	10	185	65	10
4	185	65	10	185	-5	10

Table 5.3.10-2: Determination of Gpath (Hom) (Source: Umweltbundesamt [9])

G-Profile S -> O				G-Profile O -> R			
from (m)	to (m)	length (m)	G	from (m)	to (m)	length (m)	G
0.00	40.88	40.88	0.9	0.00	21.82	21.82	0.2
40.88	143.07	102.19	0.5			Gpath	0.20
143.07	172.35	29.28	0.2				
		Gpath	0.54				

Table 5.3.10-3: G-profile on the lateral detours (Hom) (Source: Umweltbundesamt [9])

G-Profile lateral right				G-Profile lateral left			
from (m)	to (m)	length (m)	G	from (m)	to (m)	length (m)	G
0.00	40.36	40.36	0.9	0.00	41.16	41.16	0.9
40.36	141.27	100.90	0.5	41.16	144.05	102.90	0.5
141.27	179.61	38.34	0.2	144.05	169.78	25.72	0.2
179.61	199.61	20.00	0.2	169.78	194.78	25.00	0.2
		Gpath	0.49			Gpath	0.51

Table 5.3.10-4: Height profiles for the direct and the two lateral ways for Hom (Source: Umweltbundesamt [9])

z-Profile S-O		z-Profile O-R		z-Profile right		z-Profile left	
u (m)	z (m)	u (m)	z (m)	u (m)	z (m)	u (m)	z (m)
0.00	0.00	172.35	9.02	0.00	0.00	0.00	0.00
112.41	0.00	178.84	10.00	111.00	0.00	113.19	0.00
172.35	9.02	194.16	10.00	176.58	10.00	169.78	8.46
				179.61	10.00	179.78	10.00
				199.61	10.00	194.78	10.00

Table 5.3.10-5: z-height profile along the propagation path (Source: Umweltbundesamt [9])

z-Profile S - R		
No.	u (m)	v (m)
1	0.00	0.00
2	112.41	0.00
3	172.35	9.02
4	172.35	16.00
5	172.35	9.02
6	178.84	10.00
7	194.16	10.00

Table 5.3.10-6: Mean ground levels MGL and average ground factors (Hom) (Source: Umweltbundesamt [9])

Parameters	S -> O1	On -> R	S->R ri	S->R le
a (MGL)	0.04	0.03	0.06	0.05
b (MGL)	-2.05	3.99	-2.98	-2.82
z1	3.04	6.49	3.97	3.81
z2	10.81	3.79	5.42	6.23
dp	172.82	21.74	200.03	195.20
Gpath	0.54	0.20	0.49	0.51
G'path	0.75		0.61	0.64

Table 5.3.10-7: Coordinates of the mirror points (Hom) (Source: Umweltbundesamt [9])

Mirror points	u	v
S' (S -> O)	0.26	-5.08
R' (O -> R)	194.41	6.42

Table 5.3.10-8: Detour calculation due to sound barriers (Source: Umweltbundesamt [9])

Para-meters	S -> R		S '-> R		S -> R'		Lateral right		Lateral left	
	Hom	Fav	Hom	Fav	Hom	Fav	Hom	Fav	Hom	Fav
KA1	4	4	4	4	4	4	-	-	-	-
KA2	4	4	4	4	4	4	-	-	-	-
dir	194.60	194.73	194.85	194.97	194.48	194.61	194.60	194.60	194.60	194.60
dss	173.00	173.09	173.38	173.47	173.00	173.09	180.01	180.01	170.16	170.16
dsr	21.91	21.91	21.91	21.91	24.05	24.05	20.03	20.03	25.05	25.05
e	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
z	0.31	0.27	0.44	0.40	2.57	2.53	5.44	5.44	0.61	0.61

Table 5.3.10-9: Calculation of A boundary (Hom) (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000
$\Delta_{dif(S,R)}$	7.23	8.77	10.82	13.25	15.94	18.78	21.70	24.67
$A_{ground,(S,O)}$	-0.74	-0.74	-0.74	-0.74	-0.74	-0.74	-0.74	-0.74
$A_{ground,(O,R)}$	-2.40	-2.40	-2.40	-2.40	-2.40	-2.40	-2.40	-2.40
$\Delta_{dif(S',R)}$	7.97	9.77	12.04	14.62	17.40	20.29	23.24	26.22
$\Delta_{dif(S,R')}$	13.43	16.10	18.95	21.88	24.84	27.83	30.83	33.84
$\Delta_{ground(S,O)}$	-0.69	-0.67	-0.65	-0.64	-0.63	-0.63	-0.63	-0.63
$\Delta_{ground(O,R)}$	-1.26	-1.11	-1.02	-0.97	-0.94	-0.92	-0.92	-0.91
A_{dif}	5.29	6.99	9.14	11.64	14.37	17.23	20.16	23.13
$A_{ground(S,R)}$	-	-	-	-	-	-	-	-
$A_{boundary,H}$	**5.29**	**6.99**	**9.14**	**11.64**	**14.37**	**17.23**	**20.16**	**23.13**

Table 5.3.10-10: Calculation of A boundary (Fav) (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000
$\Delta_{dif(S,R)}$	7.00	8.44	10.40	12.77	15.42	18.24	21.15	24.11
$A_{ground,(S,O)}$	-0.74	-0.74	-0.74	-0.74	-0.74	-0.74	-0.74	-0.74
$A_{ground,(O,R)}$	-2.40	-2.40	-2.40	-2.40	-2.40	-2.40	-2.40	-2.40
$\Delta_{dif(S',R)}$	7.78	9.51	11.73	14.27	17.03	19.91	22.86	25.83
$\Delta_{dif(S,R')}$	13.38	16.04	18.89	21.81	24.78	27.77	30.77	33.77
$\Delta_{ground(S,O)}$	-0.68	-0.66	-0.64	-0.63	-0.62	-0.62	-0.62	-0.62
$\Delta_{ground(O,R)}$	-1.23	-1.08	-0.98	-0.92	-0.89	-0.88	-0.87	-0.86
A_{dif}	5.08	6.70	8.77	11.21	13.91	16.75	19.67	22.63
$A_{ground(S,R)}$	-	-	-	-	-	-	-	-
$A_{boundary,H}$	**5.08**	**6.70**	**8.77**	**11.21**	**13.91**	**16.75**	**19.67**	**22.63**

Table 5.3.10-11: Spectral intermediate and final results for the vertical propagation plane (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	
L_W in dB	93	93	93	93	93	93	93	93	
α_{atm}	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.02	0.08	0.20	0.38	0.71	1.88	6.38	22.75	
A_{div} in dB	56.78	56.78	56.78	56.78	56.78	56.78	56.78	56.78	
$A_{boundary,H}$ in dB	5.29	6.99	9.14	11.64	14.37	17.23	20.16	23.13	
$A_{boundary,F}$ in dB	5.08	6.70	8.77	11.21	13.91	16.75	19.67	22.63	**Total**
L_H in dB	30.91	29.15	26.87	24.20	21.14	17.11	9.68	-9.66	34.76
L_F in dB	31.12	29.44	27.24	24.63	21.60	17.59	10.17	-9.16	35.06
L in dB	31.01	29.30	27.06	24.42	21.37	17.36	9.93	-9.40	34.91
A-weighting dB	-26.2	-16.1	-8.6	-3.2	0.0	1.2	1.0	-1.1	
$L_A{}^a$ in dB	**4.81**	**13.20**	**18.46**	**21.22**	**21.37**	**18.56**	**10.93**	**-10.50**	**26.51**

Table 5.3.10-12: Ground attenuation for lateral propagation (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000
lateral right								
w hom	0.00	0.00	0.00	0.02	0.13	0.66	3.30	15.18
Cf hom	208.30	227.21	218.07	92.50	11.44	1.51	0.30	0.07
A ground-right hom	**-1.17**	**-1.17**	**-0.95**	**-0.15**	**-1.17**	**-1.17**	**-1.17**	**-1.17**
w fav	0.00	0.00	0.00	0.01	0.07	0.40	2.04	9.84
Cf fav	205.16	219.82	232.30	138.54	24.62	2.57	0.49	0.10
A ground-right fav	**-1.17**	**-1.17**	**-1.17**	**-1.17**	**-1.17**	**-1.17**	**-1.17**	**-1.17**
lateral left								
w hom	0.00	0.00	0.00	0.03	0.14	0.75	3.72	16.84
Cf hom	204.07	223.16	208.00	81.73	9.55	1.33	0.27	0.06
A ground- left hom	**-1.07**	**-1.07**	**-1.07**	**-1.07**	**-1.07**	**-1.07**	**-1.07**	**-1.07**
w fav	0.00	0.00	0.00	0.01	0.08	0.42	2.17	10.40
Cf fav	200.40	215.06	226.13	131.60	22.68	2.41	0.46	0.10
A ground- left Fav	**-1.07**	**-1.07**	**-1.07**	**-1.07**	**-1.07**	**-1.07**	**-1.07**	**-1.07**

Table 5.3.10-13: Calculation of the unweighted partial level for the right detour (Hom) (Source: Umweltbundesamt [9])

Lateral right H									
Frequency (Hz)-->	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	
L_W in dB	93	93	93	93	93	93	93	93	
α-atm(10°,70%)	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.02	0.08	0.21	0.39	0.73	1.93	6.56	23.38	
A_{div} in dB	56.78	56.78	56.78	56.78	56.78	56.78	56.78	56.78	
$A_{ground,H}$ in dB	-1.17	-1.17	-0.95	-0.15	-1.17	-1.17	-1.17	-1.17	
$\Delta_{dif,H}$ in dB	16.37	19.19	22.12	25.09	28.08	31.08	34.09	37.09	
A_H in dB	72.01	74.89	78.16	82.11	84.43	88.63	96.26	116.09	**Total**
L_H in dB	**20.99**	**18.11**	**14.84**	**10.89**	**8.57**	**4.37**	**-3.26**	**-23.09**	**23.87**

Table 5.3.10-14: Calculation of the unweighted partial level for the right detour (Fav) (Source: Umweltbundesamt [9])

Lateral right F									
Frequency (Hz)-->	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	
L_W in dB	93	93	93	93	93	93	93	93	
α-atm(10°,70%)	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.02	0.08	0.21	0.39	0.73	1.93	6.56	23.38	
A_{div} in dB	56.78	56.78	56.78	56.78	56.78	56.78	56.78	56.78	
$A_{ground,F}$ in dB	-1.17	-1.17	-1.17	-1.17	-1.17	-1.17	-1.17	-1.17	
$\Delta_{dif,F}$ in dB	16.37	19.19	22.12	25.09	28.08	31.08	34.09	37.09	
A_F in dB	72.01	74.89	77.95	81.09	84.43	88.63	96.26	116.09	**Total**
L_F in dB	**20.99**	**18.11**	**15.05**	**11.91**	**8.57**	**4.37**	**-3.26**	**-23.09**	**23.95**

Table 5.3.10-15: Calculation of the unweighted partial level for the left detour (Hom) (Source: Umweltbundesamt [9])

Lateral left H									
Frequency (Hz)-->	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	
L_W in dB	93	93	93	93	93	93	93	93	
α-atm(10°,70%)	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.02	0.08	0.20	0.38	0.71	1.89	6.40	22.82	
A_{div} in dB	56.78	56.78	56.78	56.78	56.78	56.78	56.78	56.78	
$A_{ground,H}$ in dB	-1.07	-1.07	-1.07	-1.07	-1.07	-1.07	-1.07	-1.07	
$\Delta_{dif,H}$ in dB	8.78	10.80	13.23	15.92	18.76	21.69	24.65	27.64	
A_H in dB	64.52	66.60	69.16	72.02	75.20	79.29	86.77	106.18	**Total**
L_H in dB	**28.48**	**26.40**	**23.84**	**20.98**	**17.80**	**13.71**	**6.23**	**-13.18**	**32.03**

Table 5.3.10-16: Calculation of the unweighted partial level for the left detour (Fav) (Source: Umweltbundesamt [9])

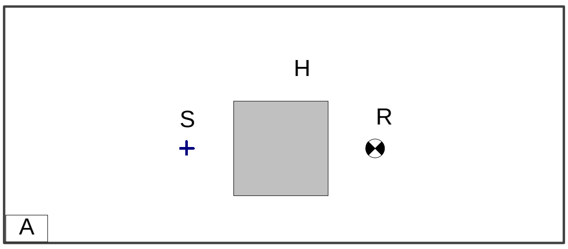
Lateral left F									
Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	
L_W in dB	93	93	93	93	93	93	93	93	
α-atm(10°,70%)	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.02	0.08	0.20	0.38	0.71	1.89	6.40	22.82	
A_{div} in dB	56.78	56.78	56.78	56.78	56.78	56.78	56.78	56.78	
$A_{ground,F}$ in dB	-1.07	-1.07	-1.07	-1.07	-1.07	-1.07	-1.07	-1.07	
$\Delta_{dif,F}$ in dB	8.78	10.80	13.23	15.92	18.76	21.69	24.65	27.64	
A_F in dB	64.52	66.60	69.16	72.02	75.20	79.29	86.77	106.18	**Total**
L_F in dB	**28.48**	**26.40**	**23.84**	**20.98**	**17.80**	**13.71**	**6.23**	**-13.18**	**32.03**

Table 5.3.10-17: Calculation of the A-weighted total level (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	
L_H(vert) in dB	30.91	29.15	26.87	24.20	21.14	17.11	9.68	-9.66	
L_H (right) in dB	20.99	18.11	14.84	10.89	8.57	4.37	-3.26	-23.09	
L_H (left) in dB	28.48	26.40	23.84	20.98	17.80	13.71	6.23	-13.18	
L_H(tot) in dB	33.14	31.22	28.80	26.03	22.95	18.90	11.45	-7.93	
L_H(vert) in dB	31.12	29.44	27.24	24.63	21.60	17.59	10.17	-9.16	
L_F(right) in dB	20.99	18.11	15.05	11.91	8.57	4.37	-3.26	-23.09	
L_F(left) in dB	28.48	26.40	23.84	20.98	17.80	13.71	6.23	-13.18	
L_F(tot) in dB	33.27	31.40	29.05	26.35	23.26	19.22	11.78	-7.59	**Total**
L in dB	33.21	31.31	28.93	26.19	23.11	19.07	11.62	-7.75	**36.94**
A-correction in dB	-26.2	-16.1	-8.6	-3.2	0	1.2	1	-1.1	
L_A in dB	**7.01**	**15.21**	**20.33**	**22.99**	**23.11**	**20.27**	**12.62**	**-8.85**	**28.29**

5.3.11 TC 10 - Sound barrier cubic house on level ground homogeneous ground factor G with immission point close to ground level

Figure 5.3.11-1: Cubic house on level ground (S source, R immission point, H house, A area) (Source: Umweltbundesamt [9])



Barrier calculation for a cubic house - the simplest scenario for applying multiple diffractions for the vertical and lateral planes.

Table 5.3.11-1: Coordinates of source S and point of immission R (Source: Umweltbundesamt [9])

Point	x (m)	y (m)	z (abs) (m)
S	50	10	1
R	70	10	4

Table 5.3.11-2: Coordinates of the houses (Source: Umweltbundesamt [9])

Building No.	Corner No.	x (m)	y (m)	z (abs) (m)
1	1	55.00	5.00	10
1	2	65.00	5.00	10
1	3	65.00	15.00	10
1	4	55.00	15.00	10

Table 5.3.11-3: z-height profile along the propagation path (Source: Umweltbundesamt [9])

z-Profile S - R		
No.	u (m)	v (m)
1	0.00	0.00
2	5.00	0.00
3	5.00	10.00
4	15.00	10.00
5	15.00	0.00
6	20.00	0.00

Table 5.3.11-4: Mean ground levels MGL and average ground factors (Hom) (Source: Umweltbundesamt [9])

Parameters	S -> O1	On -> R	S->R ri	S->R le
a (MGL)	0.00	0.00	0.00	0.00
b (MGL)	0.00	0.00	0.00	0.00
z1	1.00	10.00	1.00	1.00
z2	10.00	4.00	4.00	4.00
dp	5.00	5.00	24.15	24.15
Gpath	0.50	0.50	0.50	0.50
G'path	0.50		0.50	0.50

Table 5.3.11-5: Coordinates of the mirror points (Hom) (Source: Umweltbundesamt [9])

Mirror points	u	v
S' (S -> O)	0.00	-1.00
R' (O -> R)	20.00	-4.00

Table 5.3.11-6: Detour calculation due to sound barriers (Source: Umweltbundesamt [9])

Para-meters	S -> R		S '-> R		S -> R'		Lateral right		Lateral left	
	Hom	Fav	Hom	Fav	Hom	Fav	Hom	Fav	Hom	Fav
KA1	3	3	3	3	3	3	-	-	-	-
KA2	4	4	4	4	4	4	-	-	-	-
dir	20.22	20.22	20.62	20.62	20.62	20.62	20.22	20.22	20.22	20.22
dss	10.30	10.30	12.08	12.08	10.30	10.30	7.11	7.11	7.11	7.11
dsr	7.81	7.81	7.81	7.81	14.87	14.87	7.11	7.11	7.11	7.11
e	10.00	10.00	10.00	10.00	10.00	10.00	10.11	10.11	10.11	10.11
z	7.88	7.88	9.28	9.28	14.55	14.55	4.12	4.12	4.12	4.12

Table 5.3.11-7: Calculation of A boundary (Hom) (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000
$\Delta_{dif(S,R)}$	18.23	21.88	26.33	30.63	34.21	37.39	40.45	43.47
$A_{ground,(S,O)}$	-1.50	-1.50	-1.50	-1.50	-1.50	-1.50	-1.50	-1.50
$A_{ground,(O,R)}$	-1.50	-1.50	-1.50	-1.50	-1.50	-1.50	-1.50	-1.50
$\Delta_{dif(S',R)}$	18.91	22.58	27.03	31.33	34.92	38.10	41.16	44.18
$\Delta_{dif(S,R')}$	20.80	24.51	28.97	33.28	36.87	40.05	43.11	46.13
$\Delta_{ground(S,O)}$	-1.40	-1.39	-1.39	-1.39	-1.39	-1.39	-1.39	-1.39
$\Delta_{ground(O,R)}$	-1.14	-1.13	-1.13	-1.13	-1.13	-1.13	-1.13	-1.13
A_{dif}	15.69	19.36	22.48	22.48	22.48	22.48	22.48	22.48
$A_{ground(S,R)}$	-	-	-	-	-	-	-	-
$A_{boundary,H}$	**15.69**	**19.36**	**22.48**	**22.48**	**22.48**	**22.48**	**22.48**	**22.48**

Table 5.3.11-8: Calculation of A boundary (Fav) (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000
$\Delta_{dif(S,R)}$	18.23	21.88	26.32	30.63	34.21	37.39	40.45	43.47
$A_{ground,(S,O)}$	-1.50	-1.50	-1.50	-1.50	-1.50	-1.50	-1.50	-1.50
$A_{ground,(O,R)}$	-1.50	-1.50	-1.50	-1.50	-1.50	-1.50	-1.50	-1.50
$\Delta_{dif(S',R)}$	18.91	22.58	27.03	31.33	34.92	38.10	41.16	44.18
$\Delta_{dif(S,R')}$	20.80	24.51	28.97	33.28	36.87	40.05	43.11	46.13
$\Delta_{ground(S,O)}$	-1.40	-1.39	-1.39	-1.39	-1.39	-1.39	-1.39	-1.39
$\Delta_{ground(O,R)}$	-1.14	-1.13	-1.13	-1.13	-1.13	-1.13	-1.13	-1.13
A_{dif}	15.69	19.36	22.48	22.48	22.48	22.48	22.48	22.48
$A_{ground(S,R)}$	-	-	-	-	-	-	-	-
$A_{boundary,H}$	**15.69**	**19.36**	**22.48**	**22.48**	**22.48**	**22.48**	**22.48**	**22.48**

Table 5.3.11-9: Spectral intermediate and final results for the vertical propagation plane (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	
L_W in dB	93	93	93	93	93	93	93	93	
α_{atm}	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.00	0.01	0.02	0.04	0.07	0.20	0.66	2.36	
A_{div} in dB	37.12	37.12	37.12	37.12	37.12	37.12	37.12	37.12	
$A_{boundary,H}$ in dB	15.69	19.36	22.48	22.48	22.48	22.48	22.48	22.48	
$A_{boundary,F}$ in dB	15.69	19.36	22.48	22.48	22.48	22.48	22.48	22.48	**Total**
L_H in dB	40.19	36.52	33.38	33.36	33.33	33.21	32.74	31.04	44.26
L_F in dB	40.19	36.52	33.38	33.36	33.33	33.21	32.74	31.04	44.26
L in dB	40.19	36.52	33.38	33.36	33.33	33.21	32.74	31.04	44.26
A-weighting dB	-26.2	-16.1	-8.6	-3.2	0.0	1.2	1.0	-1.1	
L_A^a in dB	**13.99**	**20.42**	**24.78**	**30.16**	**33.33**	**34.41**	**33.74**	**29.94**	**39.88**

Table 5.3.11-10: Ground attenuation for lateral propagation (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000
lateral right								
w hom	0.00	0.00	0.00	0.01	0.08	0.41	2.10	10.13
Cf hom	24.24	24.59	26.01	28.28	20.54	5.05	0.52	0.10
A ground-right hom	**-1.50**	**-1.50**	**-1.50**	**-1.50**	**-1.50**	**-1.50**	**-1.50**	**-1.50**
w fav	0.00	0.00	0.00	0.01	0.08	0.41	2.10	10.13
Cf fav	24.24	24.59	26.01	28.28	20.54	5.05	0.52	0.10
A ground-right fav	**-1.50**	**-1.50**	**-1.50**	**-1.50**	**-1.50**	**-1.50**	**-1.50**	**-1.50**
lateral left								
w hom	0.00	0.00	0.00	0.01	0.08	0.41	2.10	10.13
Cf hom	24.24	24.59	26.01	28.28	20.54	5.05	0.52	0.10
A ground- left hom	**-1.50**	**-1.50**	**-1.50**	**-1.50**	**-1.50**	**-1.50**	**-1.50**	**-1.50**
w fav	0.00	0.00	0.00	0.01	0.08	0.41	2.10	10.13
Cf fav	24.24	24.59	26.01	28.28	20.54	5.05	0.52	0.10
A ground- left Fav	**-1.50**	**-1.50**	**-1.50**	**-1.50**	**-1.50**	**-1.50**	**-1.50**	**-1.50**

Table 5.3.11-11: Calculation of the unweighted partial level for the right detour (Hom) (Source: Umweltbundesamt [9])

Lateral right H									
Frequency (Hz)-->	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	
L_W in dB	93	93	93	93	93	93	93	93	
α-atm(10°,70%)	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.00	0.01	0.03	0.05	0.09	0.24	0.80	2.84	
A_{div} in dB	37.12	37.12	37.12	37.12	37.12	37.12	37.12	37.12	
$A_{ground,H}$ in dB	-1.50	-1.50	-1.50	-1.50	-1.50	-1.50	-1.50	-1.50	
$\Delta_{dif,H}$ in dB	15.59	19.16	23.56	27.83	31.40	34.58	37.63	40.65	
A_H in dB	51.21	54.78	59.20	63.49	67.10	70.43	74.04	79.11	**Total**
L_H in dB	**41.79**	**38.22**	**33.80**	**29.51**	**25.90**	**22.57**	**18.96**	**13.89**	**44.10**

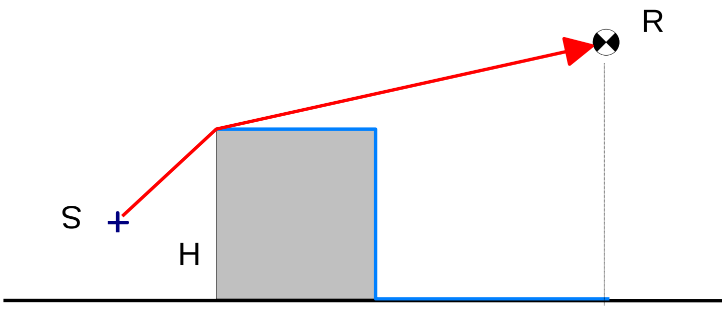
Table 5.3.11-12: Calculation of the A-weighted total level (Source: Umweltbundesamt [9])

Frequency (Hz)-->	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	
L_H(vert) in dB	40.19	36.52	33.38	33.36	33.33	33.21	32.74	31.04	
L_H (right) in dB	41.79	38.22	33.80	29.51	25.90	22.57	18.96	13.89	
L_H (left) in dB	41.79	38.22	33.80	29.51	25.90	22.57	18.96	13.89	
L_H(tot) in dB	46.09	42.49	38.44	35.97	34.67	33.90	33.09	31.20	
L_H(vert) in dB	40.19	36.52	33.38	33.36	33.33	33.21	32.74	31.04	
L_F(right) in dB	41.79	38.22	33.80	29.51	25.90	22.57	18.96	13.89	
L_F(left) in dB	41.79	38.22	33.80	29.51	25.90	22.57	18.96	13.89	
L_F(tot) in dB	46.09	42.49	38.44	35.97	34.67	33.90	33.09	31.20	**Total**
L in dB	46.09	42.49	38.44	35.97	34.67	33.90	33.09	31.20	**48.92**
A-correction in dB	-26.2	-16.1	-8.6	-3.2	0	1.2	1	-1.1	
L_A in dB	**19.89**	**26.39**	**29.84**	**32.77**	**34.67**	**35.10**	**34.09**	**30.10**	**41.19**

5.3.12 TC 11 - Sound barrier cubic house on level ground with homogeneous ground factor G and high immission point

Scenario identical to TC 10, only the height of the immission point R is 15 m here.

Figure 5.3.12-1: Cross-section in vertical plane EV (Source: Umweltbundesamt [9])



Here the upper deck area of the house is included in the calculation of the mean ground level MGL for the O-R area. The section of the lateral plane with the horizontal building edges and thus a contribution of the building covering area to the MGL of the side detours must also be examined.

Table 5.3.12-1: z-height profile along the propagation path (Source: Umweltbundesamt [9])

z-Profile S - R		
No.	u (m)	v (m)
1	0.00	0.00
2	5.00	0.00
3	5.00	10.00
4	15.00	10.00
5	15.00	0.00
6	20.00	0.00

Table 5.3.12-2: Mean ground levels MGL and average ground factors (Hom) (Source: Umweltbundesamt [9])

Parameters	S -> O1	On -> R	S->R ri	S->R le
a (MGL)	0.00	-0.89	0.10	0.10
b (MGL)	0.00	17.78	-0.13	-0.13
z1	1.00	0.00	1.13	1.13
z2	10.00	11.21	12.59	12.59
dp	5.00	7.89	24.98	24.98
Gpath	0.50	0.17	0.44	0.44
G'path	0.50		0.50	0.50

Table 5.3.12-3: Coordinates of the mirror points (Hom) (Source: Umweltbundesamt [9])

Mirror points	u	v
S' (S -> O)	0.00	-1.00
R' (O -> R)	5.10	-1.76

Table 5.3.12-4: Detour calculation due to sound barriers (Source: Umweltbundesamt [9])

Para-meters	S -> R		S '-> R		S -> R'		Lateral right		Lateral left	
	Hom	Fav	Hom	Fav	Hom	Fav	Hom	Fav	Hom	Fav
KA1	3	3	3	3	3	3	-	-	-	-
KA2	3	3	3	3	3	3	-	-	-	-
dir	24.41	24.41	25.61	25.61	5.80	5.80	24.41	24.41	24.41	24.41
dss	10.30	10.30	12.08	12.08	10.30	10.30	7.89	7.89	7.89	7.89
dsr	15.81	15.81	15.81	15.81	11.76	11.76	10.05	10.05	10.05	10.05
e	0.00	0.00	0.00	0.00	0.00	0.00	9.59	9.59	9.59	9.59
z	1.69	1.69	2.28	2.28	16.25	16.25	3.12	3.12	3.12	3.12

Table 5.3.12-5: Calculation of A boundary (Hom) (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000
$\Delta_{dif(S,R)}$	11.92	14.46	17.23	20.11	23.06	26.04	29.03	32.03
$A_{ground,(S,O)}$	-1.50	-1.50	-1.50	-1.50	-1.50	-1.50	-1.50	-1.50
$A_{ground,(O,R)}$	-2.50	-2.50	-2.50	-2.50	-2.50	-2.50	-2.50	-2.50
$\Delta_{dif(S',R)}$	12.99	15.63	18.46	21.37	24.34	27.32	30.32	33.32
$\Delta_{dif(S,R')}$	20.92	23.84	26.82	29.82	32.82	35.83	38.84	41.85
$\Delta_{ground(S,O)}$	-1.34	-1.32	-1.32	-1.31	-1.31	-1.31	-1.31	-1.31
$\Delta_{ground(O,R)}$	-0.97	-0.93	-0.91	-0.90	-0.89	-0.89	-0.89	-0.89
A_{dif}	9.61	12.20	15.00	17.90	20.86	22.80	22.80	22.80
$A_{ground(S,R)}$	-	-	-	-	-	-	-	-
$A_{boundary,H}$	**9.61**	**12.20**	**15.00**	**17.90**	**20.86**	**22.80**	**22.80**	**22.80**

Table 5.3.12-6: Calculation of A boundary (Fav) (Source: Umweltbundesamt [9])

Frequenz (Hz) -->	63	125	250	500	1000	2000	4000	8000
$\Delta_{dif(S,R)}$	11,92	14,46	17,23	20,11	23,06	26,04	29,03	32,03
$A_{ground,(S,O)}$	-1,50	-1,50	-1,50	-1,50	-1,50	-1,50	-1,50	-1,50
$A_{ground,(O,R)}$	-2,50	-2,50	-2,50	-2,50	-2,50	-2,50	-2,50	-2,50
$\Delta_{dif(S',R)}$	12,99	15,63	18,46	21,37	24,34	27,32	30,32	33,32
$\Delta_{dif(S,R')}$	20,92	23,84	26,82	29,82	32,82	35,83	38,84	41,85
$\Delta_{ground(S,O)}$	-1,34	-1,32	-1,32	-1,31	-1,31	-1,31	-1,31	-1,31
$\Delta_{ground(O,R)}$	-0,97	-0,93	-0,91	-0,90	-0,89	-0,89	-0,89	-0,89
A_{dif}	9,61	12,20	15,00	17,90	20,86	22,80	22,80	22,80
$A_{ground(S,R)}$	-	-	-	-	-	-	-	-
$A_{boundary,F}$	**9,61**	**12,20**	**15,00**	**17,90**	**20,86**	**22,80**	**22,80**	**22,80**

Table 5.3.12-7: Spectral intermediate and final results for the vertical propagation plane (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	
L_W in dB	93	93	93	93	93	93	93	93	
α_{atm}	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.00	0.01	0.03	0.05	0.09	0.24	0.80	2.85	
A_{div} in dB	38.75	38.75	38.75	38.75	38.75	38.75	38.75	38.75	
$A_{boundary,H}$ in dB	9.61	12.20	15.00	17.90	20.86	22.80	22.80	22.80	
$A_{boundary,F}$ in dB	9.61	12.20	15.00	17.90	20.86	22.80	22.80	22.80	**Total**
L_H in dB	44.64	42.04	39.22	36.30	33.30	31.21	30.64	28.59	48.00
L_F in dB	44.64	42.04	39.22	36.30	33.30	31.21	30.64	28.59	48.00
L in dB	44.64	42.04	39.22	36.30	33.30	31.21	30.64	28.59	48.00
A-weighting dB	-26.2	-16.1	-8.6	-3.2	0.0	1.2	1.0	-1.1	
$L_A{}^a$ in dB	**18.44**	**25.94**	**30.62**	**33.10**	**33.30**	**32.41**	**31.64**	**27.49**	**39.80**

Table 5.3.12-8: Ground attenuation for lateral propagation (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000
lateral right								
w hom	0.00	0.00	0.00	0.01	0.08	0.40	2.07	9.99
Cf hom	25.07	25.45	26.93	29.26	21.08	5.11	0.53	0.10
A ground-right hom	**-1.51**	**-1.51**	**-1.51**	**-1.51**	**-1.51**	**-1.51**	**-1.51**	**-1.51**
w fav	0.00	0.00	0.00	0.01	0.06	0.31	1.60	7.90
Cf fav	25.05	25.34	26.56	29.11	23.63	7.01	0.74	0.13
A ground-right fav	**-1.51**	**-1.51**	**-1.51**	**-1.51**	**-1.51**	**-1.51**	**-1.51**	**-1.51**
lateral left								
w hom	0.00	0.00	0.00	0.01	0.08	0.40	2.07	9.99
Cf hom	25.07	25.45	26.93	29.26	21.08	5.11	0.53	0.10
A ground- left hom	**-1.51**	**-1.51**	**-1.51**	**-1.51**	**-1.51**	**-1.51**	**-1.51**	**-1.51**
w fav	0.00	0.00	0.00	0.01	0.06	0.31	1.60	7.90
Cf fav	25.05	25.34	26.56	29.11	23.63	7.01	0.74	0.13
A ground- left Fav	**-1.51**	**-1.51**	**-1.51**	**-1.51**	**-1.51**	**-1.51**	**-1.51**	**-1.51**

Table 5.3.12-9: Calculation of the unweighted partial level for the right detour (Hom) (Source: Umweltbundesamt [9])

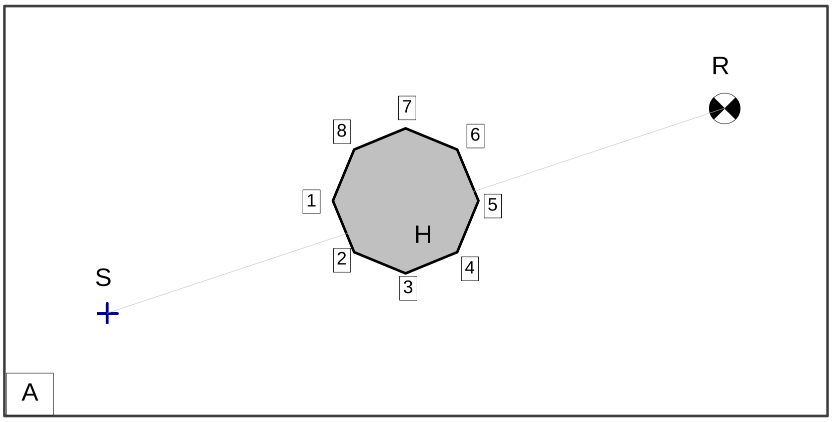
Lateral right H									
Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	
L_W in dB	93	93	93	93	93	93	93	93	
α-atm(10°,70%)	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.00	0.01	0.03	0.05	0.10	0.27	0.90	3.22	
A_{div} in dB	38.75	38.75	38.75	38.75	38.75	38.75	38.75	38.75	
$A_{ground,H}$ in dB	-1.51	-1.51	-1.51	-1.51	-1.51	-1.51	-1.51	-1.51	
$\Delta_{dif,H}$ in dB	14.47	17.92	22.26	26.57	30.18	33.37	36.43	39.45	
A_H in dB	51.72	55.18	59.53	63.86	67.52	70.88	74.57	79.91	Total
L_H in dB	**41.28**	**37.82**	**33.47**	**29.14**	**25.48**	**22.12**	**18.43**	**13.09**	**43.64**

Table 5.3.12-10: Partial and total levels for the three propagation paths (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	
L_A in dB top	18.44	25.94	30.62	33.10	33.30	32.41	31.64	27.49	
L_A in dB right	15.08	21.72	24.87	25.94	25.48	23.32	19.43	11.99	
L_A in dB left	15.08	21.72	24.87	25.94	25.48	23.32	19.43	11.99	Total
L_A in dB	**21.28**	**28.39**	**32.47**	**34.51**	**34.54**	**33.37**	**32.14**	**27.73**	**41.03**

5.3.13 TC 12 - Sound barrier octagonal house on level ground with immission point close to ground level

Figure 5.3.13-1: Octagonal house H with source S and point of immission R in area A (Source: Umweltbundesamt [9])



More complex side detours determined by several points.

Table 5.3.13-1: Coordinates of source S and point of immission R (Source: Umweltbundesamt [9])

Point	x (m)	Y (m)	z (abs) (m)
S	0	10	1
R	30	20	6

Table 5.3.13-2: Coordinates of the houses (Source: Umweltbundesamt [9])

Building No.	Corner No.	x (m)	y (m)	z (abs) (m)
1	1	10.96	15.50	10
1	2	12.00	13.00	10
1	3	14.50	11.96	10
1	4	17.00	13.00	10
1	5	18.04	15.50	10
1	6	17.00	18.00	10
1	7	14.50	19.04	10
1	8	12.00	18.00	10

Table 5.3.13-3: z-height profile along the propagation path (Source: Umweltbundesamt [9])

z-Profile S - R		
No.	u (m)	v (m)
1	0.00	0.00
2	12.26	0.00
3	12.26	10.00
4	18.82	10.00
5	18.82	0.00
6	31.62	0.00

Table 5.3.13-4: Mean ground levels MGL and average ground factors (Hom) (Source: Umweltbundesamt [9])

Parameters	S -> O1	On -> R	S->R ri	S->R le
a (MGL)	0.00	0.00	0.00	0.00
b (MGL)	0.00	0.00	0.00	0.00
z1	1.00	10.00	1.00	1.00
z2	10.00	6.00	6.00	6.00
dp	12.26	12.80	32.11	32.66
Gpath	0.50	0.50	0.50	0.50
G'path	0.50		0.50	0.50

Table 5.3.13-5: Coordinates of the mirror points (Hom) (Source: Umweltbundesamt [9])

Mirror points	u	v
S' (S -> O)	0.00	-1.00
R' (O -> R)	31.62	-6.00

Table 5.3.13-6: Detour calculation due to sound barriers (Source: Umweltbundesamt [9])

Para-meters	S -> R		S '-> R		S -> R'		Lateral right		Lateral left	
	Hom	Fav	Hom	Fav	Hom	Fav	Hom	Fav	Hom	Fav
KA1	3	3	3	3	3	3	-	-	-	-
KA2	4	4	4	4	4	4	-	-	-	-
dir	32.016	32.017	32.388	32.390	32.388	32.390	32.016	32.016	32.016	32.016
dss	15.212	15.212	16.474	16.475	15.212	15.212	14.807	14.807	14.591	14.591
dsr	13.415	13.415	13.415	13.415	20.493	20.493	14.945	14.945	15.710	15.710
e	6.554	6.554	6.554	6.554	6.554	6.554	2.741	2.741	2.741	2.741
z	3.165	3.164	4.055	4.054	9.871	9.870	0.477	0.477	1.026	1.026

Table 5.3.13-7: Calculation of A boundary (Hom) (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000
$\Delta_{dif(S,R)}$	14.37	17.50	21.47	25.97	29.98	33.36	36.47	39.50
$A_{ground,(S,O)}$	-1.50	-1.50	-1.50	-1.50	-1.50	-1.50	-1.50	-1.50
$A_{ground,(O,R)}$	-1.50	-1.50	-1.50	-1.50	-1.50	-1.50	-1.50	-1.50
$\Delta_{dif(S',R)}$	15.34	18.53	22.52	27.04	31.05	34.43	37.54	40.58
$\Delta_{dif(S,R')}$	18.98	22.28	26.34	30.89	34.91	38.29	41.41	44.44
$\Delta_{ground(S,O)}$	-1.35	-1.35	-1.34	-1.34	-1.34	-1.34	-1.34	-1.34
$\Delta_{ground(O,R)}$	-0.91	-0.90	-0.89	-0.88	-0.88	-0.88	-0.88	-0.88
A_{dif}	12.10	15.26	19.24	22.78	22.78	22.78	22.78	22.78
$A_{ground(S,R)}$	-	-	-	-	-	-	-	-
$A_{boundary,H}$	**12.10**	**15.26**	**19.24**	**22.78**	**22.78**	**22.78**	**22.78**	**22.78**

Table 5.3.13-8: Calculation of A boundary (Fav) (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000
$\Delta_{dif(S,R)}$	14.37	17.50	21.46	25.97	29.98	33.35	36.47	39.50
$A_{ground,(S,O)}$	-1.50	-1.50	-1.50	-1.50	-1.50	-1.50	-1.50	-1.50
$A_{ground,(O,R)}$	-1.50	-1.50	-1.50	-1.50	-1.50	-1.50	-1.50	-1.50
$\Delta_{dif(S',R)}$	15.34	18.52	22.52	27.04	31.05	34.43	37.54	40.58
$\Delta_{dif(S,R')}$	18.97	22.28	26.34	30.89	34.91	38.29	41.41	44.44
$\Delta_{ground(S,O)}$	-1.35	-1.35	-1.34	-1.34	-1.34	-1.34	-1.34	-1.34
$\Delta_{ground(O,R)}$	-0.91	-0.90	-0.89	-0.88	-0.88	-0.88	-0.88	-0.88
A_{dif}	12.10	15.26	19.24	22.78	22.78	22.78	22.78	22.78
$A_{ground(S,R)}$	-	-	-	-	-	-	-	-
$A_{boundary,H}$	**12.10**	**15.26**	**19.24**	**22.78**	**22.78**	**22.78**	**22.78**	**22.78**

Table 5.3.13-9: Spectral intermediate and final results for the vertical propagation plane (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	
L_W in dB	93	93	93	93	93	93	93	93	
α_{atm}	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.00	0.01	0.03	0.06	0.12	0.31	1.05	3.74	
A_{div} in dB	41.11	41.11	41.11	41.11	41.11	41.11	41.11	41.11	
$A_{boundary,H}$ in dB	12.10	15.26	19.24	22.78	22.78	22.78	22.78	22.78	
$A_{boundary,F}$ in dB	12.10	15.26	19.24	22.78	22.78	22.78	22.78	22.78	**Total**
L_H in dB	39.78	36.62	32.62	29.05	29.00	28.80	28.06	25.37	42.85
L_F in dB	39.79	36.62	32.62	29.05	29.00	28.80	28.06	25.37	42.85
L in dB	39.78	36.62	32.62	29.05	29.00	28.80	28.06	25.37	42.85
A-weighting dB	-26.2	-16.1	-8.6	-3.2	0.0	1.2	1.0	-1.1	
L_A^a in dB	**13.58**	**20.52**	**24.02**	**25.85**	**29.00**	**30.00**	**29.06**	**24.27**	**35.61**

Table 5.3.13-10: Ground attenuation for lateral propagation (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000
lateral right								
w hom	0.00	0.00	0.00	0.01	0.08	0.41	2.10	10.13
Cf hom	32.26	32.87	35.13	37.43	23.55	4.65	0.49	0.10
A ground-right hom	**-1.50**	**-1.50**	**-1.50**	**-1.50**	**-1.50**	**-1.50**	**-1.50**	**-1.50**
w fav	0.00	0.00	0.00	0.01	0.08	0.41	2.10	10.13
Cf fav	32.26	32.87	35.13	37.43	23.55	4.65	0.49	0.10
A ground-right fav	**-1.50**	**-1.50**	**-1.50**	**-1.50**	**-1.50**	**-1.50**	**-1.50**	**-1.50**
lateral left								
w hom	0.00	0.00	0.00	0.01	0.08	0.41	2.10	10.13
Cf hom	32.82	33.45	35.78	38.05	23.71	4.62	0.49	0.10
A ground- left hom	**-1.50**	**-1.50**	**-1.50**	**-1.50**	**-1.50**	**-1.50**	**-1.50**	**-1.50**
w fav	0.00	0.00	0.00	0.01	0.08	0.41	2.10	10.13
Cf fav	32.82	33.45	35.78	38.05	23.71	4.62	0.49	0.10
A ground- left Fav	**-1.50**	**-1.50**	**-1.50**	**-1.50**	**-1.50**	**-1.50**	**-1.50**	**-1.50**

Table 5.3.13-11: Calculation of the unweighted partial level for the right detour (Hom) (Source: Umweltbundesamt [9])

Lateral right H									
Frequency (Hz)-->	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	
L_W in dB	93	93	93	93	93	93	93	93	
α-atm(10°,70%)	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.00	0.01	0.03	0.06	0.12	0.31	1.06	3.80	
A_{div} in dB	41.11	41.11	41.11	41.11	41.11	41.11	41.11	41.11	
$A_{ground,H}$ in dB	-1.50	-1.50	-1.50	-1.50	-1.50	-1.50	-1.50	-1.50	
$\Delta_{dif,H}$ in dB	8.17	10.09	12.67	16.13	20.46	24.62	28.11	31.25	
A_H in dB	47.78	49.71	52.31	55.80	60.19	64.54	68.78	74.66	**Total**
L_H in dB	**45.22**	**43.29**	**40.69**	**37.20**	**32.81**	**28.46**	**24.22**	**18.34**	**48.72**

Table 5.3.13-12: Calculation of the unweighted partial level for the right detour (Fav) (Source: Umweltbundesamt [9])

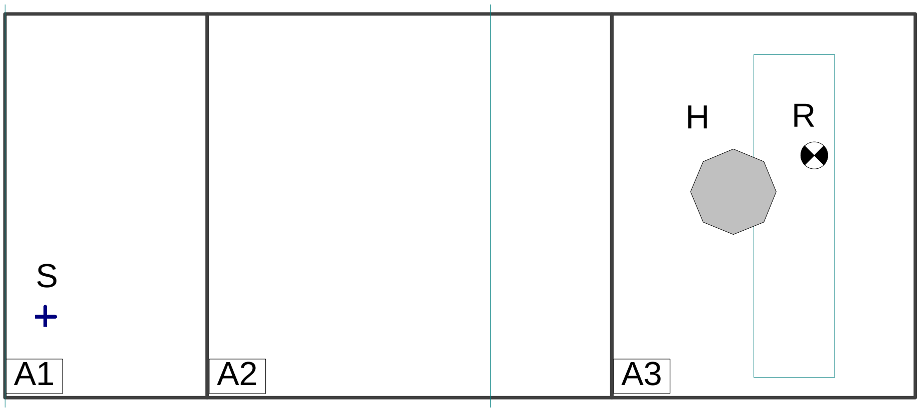
Lateral right F									
Frequency (Hz)-->	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	
L_W in dB	93	93	93	93	93	93	93	93	
α-atm(10°,70%)	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.00	0.01	0.03	0.06	0.12	0.31	1.06	3.80	
A_{div} in dB	41.11	41.11	41.11	41.11	41.11	41.11	41.11	41.11	
$A_{ground,F}$ in dB	-1.50	-1.50	-1.50	-1.50	-1.50	-1.50	-1.50	-1.50	
$\Delta_{dif,F}$ in dB	8.17	10.09	12.67	16.13	20.46	24.62	28.11	31.25	
A_F in dB	47.78	49.71	52.31	55.80	60.19	64.54	68.78	74.66	**Total**
L_F in dB	**45.22**	**43.29**	**40.69**	**37.20**	**32.81**	**28.46**	**24.22**	**18.34**	**48.72**

Table 5.3.13-13: Partial and total levels for the three propagation paths (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	
L_A in dB top	13.58	20.52	24.02	25.85	29.00	30.00	29.06	24.27	
L_A in dB right	19.02	27.19	32.09	34.00	32.81	29.66	25.22	17.24	
L_A in dB left	16.91	24.61	29.16	30.84	29.54	26.35	21.89	13.86	**Total**
L_A in dB	**21.81**	**29.66**	**34.31**	**36.14**	**35.57**	**33.72**	**31.12**	**25.37**	**41.90**

5.3.14 TC 13 – Sound barrier octagonal house on non-level ground with varying ground factors G

Figure 5.3.14-1: Octagonal house H on ground with different heights and acoustic properties (S source, R place of immission, A1 area with G=0.5, A2 area with G=0.9, A3 area with G=0.2) (Source: Umweltbundesamt [9])



Inclusion of varying terrain elevations and G-factors in the calculation of more complex lateral detours.

Table 5.3.14-1: Coordinates of source S and point of immission R (Source: Umweltbundesamt [9])

Point	x (m)	y (m)	z (abs) (m)
S	10	10	1
R	200	50	28.5

Table 5.3.14-2: Contour lines to describe the ground model (Source: Umweltbundesamt [9])

No.	x1 (m)	y1 (m)	z1 (m)	x2 (m)	y2 (m)	z2 (m)
1	185	-5	10	205	-5	10
2	205	-5	10	205	75	10
3	205	75	10	185	75	10
4	185	75	10	185	-5	10

Table 5.3.14-3: Rectangular areas with a given ground index G (Source: Umweltbundesamt [9])

G	x (m)		y (m)	
	min	max	min	max
0.5	0.00	50.00	-10.00	85.00
0.9	50.00	150.00	-10.00	85.00
0.2	150.00	225.00	-10.00	85.00

Table 5.3.14-4: Coordinates of the buildings (Source: Umweltbundesamt [9])

Building No.	Corner No.	x (m)	y (m)	z (abs) (m)
1	1	169.39	41.00	30
1	2	172.50	33.50	30
1	3	180.00	30.39	30
1	4	187.50	33.50	30
1	5	190.61	41.00	30
1	6	187.50	48.50	30
1	7	180.00	51.61	30
1	8	172.50	48.50	30

Table 5.3.14-5: Determination of Gpath (Hom) (Source: Umweltbundesamt [9])

G-Profile S -> O				G-Profile O -> R			
from (m)	to (m)	length (m)	G	from (m)	to (m)	length (m)	G
0.00	40.88	40.88	0.5	0.00	12.33	12.33	0.2
40.88	143.07	102.19	0.9			Gpath	0.2
143.07	164.07	21.00	0.2				
		Gpath	0.7107				

Table 5.3.14-6: G-profile on the lateral detours (Hom) (Source: Umweltbundesamt [9])

G-Profile lateral right				G-Profile lateral left			
from (m)	to (m)	length (m)	G	from (m)	to (m)	length (m)	G
0.00	40.29	40.29	0.5	0.00	41.18	41.18	0.5
40.29	141.00	100.72	0.9	41.18	144.13	102.95	0.9
141.00	171.22	30.21	0.2	144.13	175.02	30.88	0.2
171.22	179.34	8.12	0.2	175.02	195.08	20.07	0.2
179.34	200.04	20.70	0.2			Gpath	0.6327
		Gpath	0.6129				

Table 5.3.14-7: Height profiles for the direct and the two lateral ways for Hom (Source: Umweltbundesamt [9])

z-Profile S-O		z-Profile O-R		z-Profile right		z-Profile left	
u (m)	z (m)	u (m)	z (m)	u (m)	z (m)	u (m)	z (m)
0.00	0.00	181.83	10.00	0.00	0.00	0.00	0.00
112.41	0.00	194.16	10.00	110.79	0.00	113.25	0.00
164.07	7.78			110.79	0.00	175.02	9.23
				171.22	9.23	180.04	10.00
				176.63	10.00	195.08	10.00
				179.34	10.00		
				200.04	10.00		

Table 5.3.14-8: z-height profile along the propagation path (Source: Umweltbundesamt [9])

z-Profile S - R		
No.	u (m)	v (m)
1	0.00	0.00
2	112.41	0.00
3	164.07	7.78
4	164.07	30.00
5	181.83	30.00
6	181.83	10.00
7	194.16	10.00

Table 5.3.14-9: Mean ground levels MGL and average ground factors (Hom) (Source: Umweltbundesamt [9])

Parameters	S -> O1	On -> R	S->R ri	S->R le
a (MGL)	0.04	0.00	0.06	0.05
b (MGL)	-1.68	10.00	-2.99	-2.82
z1	2.68	20.00	3.98	3.82
z2	25.86	18.50	19.83	20.69
dp	164.99	12.33	201.30	196.29
Gpath	0.71	0.20	0.61	0.63
G'path	0.54		0.53	0.54

Table 5.3.14-10: Coordinates of the mirror points (Hom) (Source: Umweltbundesamt [9])

Mirror points	u	v
S' (S -> O)	0.19	-4.35
R' (O -> R)	194.16	-8.50

Table 5.3.14-11: Detour calculation due to sound barriers (Source: Umweltbundesamt [9])

Para-meters	S -> R		S '-> R		S -> R'		Lateral right		Lateral left	
	Hom	Fav	Hom	Fav	Hom	Fav	Hom	Fav	Hom	Fav
KA1	4	4	4	4	4	4	-	-	-	-
KA2	5	5	5	5	5	5	-	-	-	-
dir	196.10	196.23	196.74	196.87	194.40	194.52	196.10	196.10	196.10	196.10
dss	166.61	166.69	167.44	167.52	166.61	166.69	172.91	172.91	176.76	176.76
dsr	12.42	12.42	12.42	12.42	40.43	40.43	20.82	20.82	20.25	20.25
e	17.76	17.76	17.76	17.76	17.76	17.76	8.20	8.20	0.00	0.00
z	0.70	0.65	0.89	0.84	30.41	30.36	5.83	5.83	0.91	0.91

Table 5.3.14-12: Calculation of A boundary (Hom) (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000
$\Delta_{dif(S,R)}$	9.76	13.15	17.15	20.71	23.88	26.92	29.93	32.94
$A_{ground,(S,O)}$	-1.38	-1.38	-1.38	-1.38	-1.38	-1.38	-1.38	-1.38
$A_{ground,(O,R)}$	-2.40	-2.40	-2.40	-2.40	-2.40	-2.40	-2.40	-2.40
$\Delta_{dif(S',R)}$	10.52	14.08	18.17	21.75	24.94	27.98	31.00	34.01
$\Delta_{dif(S,R')}$	24.55	28.89	33.30	37.00	40.23	43.30	46.32	49.34
$\Delta_{ground(S,O)}$	-1.27	-1.25	-1.24	-1.23	-1.23	-1.23	-1.23	-1.23
$\Delta_{ground(O,R)}$	-0.49	-0.44	-0.42	-0.41	-0.41	-0.41	-0.41	-0.41
A_{dif}	8.00	11.46	15.50	19.06	22.24	23.36	23.36	23.36
$A_{ground(S,R)}$	-	-	-	-	-	-	-	-
$A_{boundary,H}$	**8.00**	**11.46**	**15.50**	**19.06**	**22.24**	**23.36**	**23.36**	**23.36**

Table 5.3.14-13: Calculation of A boundary (Fav) (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000
$\Delta_{dif(S,R)}$	9.54	12.88	16.85	20.40	23.57	26.60	29.62	32.62
$A_{ground,(S,O)}$	-1.38	-1.38	-1.38	-1.38	-1.38	-1.38	-1.38	-1.38
$A_{ground,(O,R)}$	-2.40	-2.40	-2.40	-2.40	-2.40	-2.40	-2.40	-2.40
$\Delta_{dif(S',R)}$	10.34	13.86	17.93	21.51	24.69	27.74	30.75	33.76
$\Delta_{dif(S,R')}$	24.55	28.88	33.30	37.00	40.22	43.29	46.32	49.33
$\Delta_{ground(S,O)}$	-1.27	-1.24	-1.23	-1.22	-1.22	-1.22	-1.22	-1.22
$\Delta_{ground(O,R)}$	-0.48	-0.43	-0.41	-0.40	-0.40	-0.40	-0.40	-0.39
A_{dif}	7.80	11.21	15.22	18.78	21.95	23.38	23.38	23.38
$A_{ground(S,R)}$	-	-	-	-	-	-	-	-
$A_{boundary,H}$	**7.80**	**11.21**	**15.22**	**18.78**	**21.95**	**23.38**	**23.38**	**23.38**

Table 5.3.14-14: Spectral intermediate and final results for the vertical propagation plane (Source: Umweltbundesamt [9])

Frequenz (Hz) -->	63	125	250	500	1000	2000	4000	8000	
L_W in dB	93	93	93	93	93	93	93	93	
α_{atm}	0,12	0,41	1,04	1,93	3,66	9,66	32,77	116,88	
A_{atm} in dB	0,02	0,08	0,20	0,38	0,72	1,90	6,43	22,92	
A_{div} in dB	56,85	56,85	56,85	56,85	56,85	56,85	56,85	56,85	
$A_{boundary,H}$ in dB	8,00	11,46	15,50	19,06	22,24	23,36	23,36	23,36	
$A_{boundary,F}$ in dB	7,80	11,21	15,22	18,78	21,95	23,38	23,38	23,38	**Gesamt**
L_H in dB	28,13	24,61	20,45	16,71	13,19	10,90	6,36	-10,13	30,55
L_F in dB	28,33	24,86	20,73	17,00	13,49	10,87	6,34	-10,16	30,77
L in dB	28,23	24,73	20,59	16,85	13,34	10,88	6,35	-10,14	30,66
A-weighting dB	-26,2	-16,1	-8,6	-3,2	0,0	1,2	1,0	-1,1	
$L_A{}^a$ in dB	**2,03**	**8,63**	**11,99**	**13,65**	**13,34**	**12,08**	**7,35**	**-11,24**	**19,60**

Table 5.3.14-15: Soil attenuation for lateral propagation (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000
lateral right								
w hom	0.00	0.00	0.00	0.02	0.09	0.48	2.42	11.50
Cf hom	207.46	223.88	230.36	122.25	18.84	2.12	0.41	0.09
A ground-right hom	**-1.40**	**-1.40**	**-1.40**	**-1.40**	**-1.40**	**-1.40**	**-1.40**	**-1.40**
w fav	0.00	0.00	0.00	0.02	0.13	0.67	3.32	15.27
Cf fav	209.72	228.83	218.90	92.01	11.30	1.50	0.30	0.07
A ground-right fav	**-1.40**	**-1.40**	**-1.40**	**-1.40**	**-1.40**	**-1.40**	**-1.40**	**-1.40**
lateral left								
w hom	0.00	0.00	0.00	0.02	0.09	0.48	2.46	11.67
Cf hom	202.25	218.20	224.79	119.88	18.59	2.08	0.41	0.09
A ground- left hom	**-1.39**	**-1.39**	**-1.39**	**-1.39**	**-1.39**	**-1.39**	**-1.39**	**-1.39**
w fav	0.00	0.00	0.00	0.03	0.14	0.72	3.56	16.24
Cf fav	204.90	223.86	211.09	85.42	10.19	1.39	0.28	0.06
A ground- left Fav	**-1.39**	**-1.39**	**-1.39**	**-1.39**	**-1.39**	**-1.39**	**-1.39**	**-1.39**

Table 5.3.14-16: Calculation of the unweighted partial level for the right detour (Hom) (Source: Umweltbundesamt [9])

Lateral right H									
Frequency (Hz)-->	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	
L_W in dB	93	93	93	93	93	93	93	93	
α-atm(10°,70%)	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.02	0.08	0.21	0.39	0.74	1.95	6.62	23.60	
A_{div} in dB	56.85	56.85	56.85	56.85	56.85	56.85	56.85	56.85	
$A_{ground,H}$ in dB	-1.40	-1.40	-1.40	-1.40	-1.40	-1.40	-1.40	-1.40	
$\Delta_{dif,H}$ in dB	16.88	20.30	24.57	29.02	32.80	36.06	39.13	42.16	
A_H in dB	72.35	75.83	80.23	84.86	88.98	93.45	101.20	121.21	**Total**
L_H in dB	**20.65**	**17.17**	**12.77**	**8.14**	**4.02**	**-0.45**	**-8.20**	**-28.21**	**22.95**

Table 5.3.14-17: Calculation of the unweighted partial level for the left detour (Hom) (Source: Umweltbundesamt [9])

Lateral left H									
Frequency (Hz)-->	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	
L_W in dB	93	93	93	93	93	93	93	93	
α-atm(10°,70%)	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.02	0.08	0.21	0.38	0.72	1.90	6.46	23.03	
A_{div} in dB	56.85	56.85	56.85	56.85	56.85	56.85	56.85	56.85	
$A_{ground,H}$ in dB	-1.39	-1.39	-1.39	-1.39	-1.39	-1.39	-1.39	-1.39	
$\Delta_{dif,H}$ in dB	9.89	12.15	14.74	17.53	20.42	23.37	26.35	29.35	
A_H in dB	65.37	67.68	70.40	73.36	76.60	80.73	88.26	107.83	**Total**
L_H in dB	**27.63**	**25.32**	**22.60**	**19.64**	**16.40**	**12.27**	**4.74**	**-14.83**	**30.99**

Table 5.3.14-18: Partial and total levels for the three propagation paths (Source: Umweltbundesamt [9])

Frequency (Hz)-->	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	
L_A in dB top	2.03	8.63	11.99	13.65	13.34	12.08	7.35	-11.24	
L_A in dB right	-5.55	1.07	4.17	4.94	4.02	0.75	-7.20	-29.31	
L_A in dB left	1.43	9.22	14.00	16.44	16.40	13.47	5.74	-15.93	**Total**
L_A in dB	**5.14**	**12.29**	**16.39**	**18.47**	**18.31**	**15.97**	**9.72**	**-9.92**	**24.00**

5.3.15 TC 14 - Sound barrier octagonal house on level ground with specified ground factor G and high immission point

Figure 5.3.15-1: Octagonal house on level ground (S source, R immission point, A area) (Source: Umweltbundesamt [9])

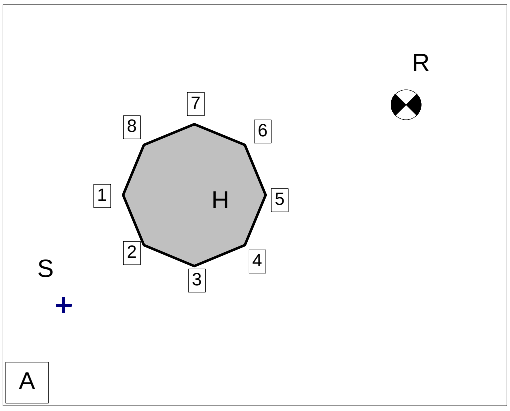
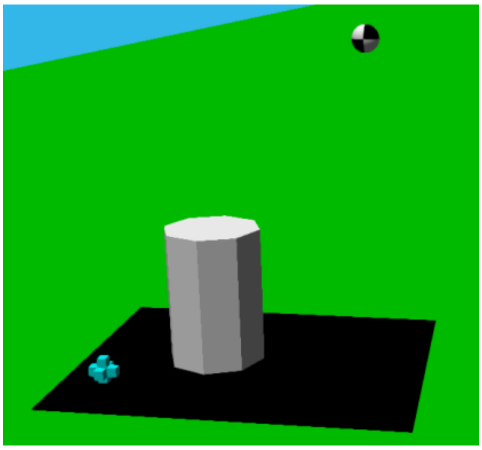


Figure 5.3.15-2: Octagonal house on level ground - 3D view (Source: Umweltbundesamt [9])



Similar to TC 11, it must be checked whether and how the house roof area is to be included in the calculation of the MGL and the average G-factors.

Table 5.3.15-1: Coordinates of source S and point of immission R (Source: Umweltbundesamt [9])

Point	x (m)	y (m)	z (abs) (m)
S	8	10	1
R	25	20	23

Table 5.3.15-2: Determination of Gpath (Hom) (Source: Umweltbundesamt [9])

G-Profile S -> O				G-Profile O -> R			
from (m)	to (m)	length (m)	G	from (m)	to (m)	length (m)	G
0.00	5.39	5.39	0.2	0.00	6.10	6.10	0
		Gpath	0.20	6.10	14.33	8.23	0.2
						Gpath	0.11

Table 5.3.15-3: G-profile on the lateral detours (Hom) (Source: Umweltbundesamt [9])

G-Profile lateral right				G-Profile lateral left			
from (m)	to (m)	length (m)	G	from (m)	to (m)	length (m)	G
0.00	6.79	6.79	0.2	0.00	8.95	8.95	0.2
6.79	8.27	1.49	0.2	8.95	9.52	0.57	0.2
8.27	8.29	0.02	0.2	9.52	9.53	0.01	0.2
8.29	10.10	1.81	0	9.53	12.48	2.95	0
10.10	20.07	9.97	0.2	12.48	22.12	9.64	0.2
		Gpath	0.18			Gpath	0.17

Table 5.3.15-4: Height profiles for the direct and the two lateral ways for Hom (Source: Umweltbundesamt [9])

z-Profile S-O		z-Profile O-R		z-Profile right		z-Profile left	
u (m)	z (m)	u (m)	z (m)	u (m)	z (m)	u (m)	z (m)
0.00	0.00	5.39	10.00	0.00	0.00	0.00	0.00
5.39	0.00	11.49	10.00	6.79	0.00	8.95	0.00
		11.49	0.00	8.27	0.00	9.52	0.00
		19.72	0.00	8.29	0.00	9.53	0.00
				8.29	10.00	9.53	10.00
				10.10	10.00	12.48	10.00
				10.10	0.00	12.48	0.00
				20.07	0.00	22.12	0.00

Table 5.3.15-5: z-height profile along the propagation path (Source: Umweltbundesamt [9])

z-Profile S - R		
No.	u (m)	v (m)
1	0.00	0.00
2	5.39	0.00
3	5.39	10.00
4	11.49	10.00
5	11.49	0.00
6	19.72	0.00

Table 5.3.15-6: Mean ground levels MGL and average ground factors (Hom) (Source: Umweltbundesamt [9])

Parameters	S -> O1	On -> R	S->R ri	S->R le
a (MGL)	0.00	-1.02	-0.02	0.00
b (MGL)	0.00	17.11	1.13	1.35
z1	1.00	0.00	0.00	0.00
z2	10.00	18.23	22.32	21.69
dp	5.39	0.72	19.57	22.08
Gpath	0.20	0.11	0.18	0.17
G'path	0.20		0.20	0.20

Table 5.3.15-7: Coordinates of the mirror points (Hom) (Source: Umweltbundesamt [9])

Mirror points	u	v
S' (S -> O)	0.00	-1.00
R' (O -> R)	-6.35	-2.48

Table 5.3.15-8: Detour calculation due to sound barriers (Source: Umweltbundesamt [9])

Para-meters	S -> R		S '-> R		S -> R'		Lateral right		Lateral left	
	Hom	Fav	Hom	Fav	Hom	Fav	Hom	Fav	Hom	Fav
KA1	3	3	3	3	3	3	-	-	-	-
KA2	3	3	3	3	3	3	-	-	-	-
dir	29.55	29.55	31.06	31.07	7.24	7.24	29.55	29.55	29.55	29.55
dss	10.49	10.49	12.25	12.25	10.49	10.49	10.01	10.01	12.25	12.25
dsr	19.35	19.35	19.35	19.35	17.13	17.13	17.55	17.55	18.10	18.10
e	0.00	0.00	0.00	0.00	0.00	0.00	2.21	2.21	0.85	0.85
z	0.29	0.29	0.54	0.54	20.38	20.38	0.23	0.23	1.66	1.66

Table 5.3.15-9: Calculation of A boundary (Hom) (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000
$\Delta_{dif(S,R)}$	7.15	8.65	10.67	13.08	15.76	18.59	21.51	24.48
$A_{ground,(S,O)}$	-2.40	-2.40	-2.40	-2.40	-2.40	-2.40	-2.40	-2.40
$A_{ground,(O,R)}$	-2.66	-2.66	-2.66	-2.66	-2.66	-2.66	-2.66	-2.66
$\Delta_{dif(S',R)}$	8.43	10.37	12.73	15.38	18.20	21.11	24.07	27.05
$\Delta_{dif(S,R')}$	21.88	24.81	27.80	30.80	33.80	36.81	39.82	42.83
$\Delta_{ground(S,O)}$	-2.11	-2.02	-1.94	-1.90	-1.87	-1.86	-1.85	-1.84
$\Delta_{ground(O,R)}$	-0.55	-0.47	-0.42	-0.39	-0.38	-0.37	-0.37	-0.37
A_{dif}	4.49	6.17	8.30	10.79	13.51	16.37	19.30	22.27
$A_{ground(S,R)}$	-	-	-	-	-	-	-	-
$A_{boundary,H}$	**4.49**	**6.17**	**8.30**	**10.79**	**13.51**	**16.37**	**19.30**	**22.27**

Table 5.3.15-10: Calculation of A boundary (Fav) (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000
$\Delta_{dif(S,R)}$	7.14	8.65	10.66	13.07	15.75	18.58	21.50	24.47
$A_{ground,(S,O)}$	-2.40	-2.40	-2.40	-2.40	-2.40	-2.40	-2.40	-2.40
$A_{ground,(O,R)}$	-2.66	-2.66	-2.66	-2.66	-2.66	-2.66	-2.66	-2.66
$\Delta_{dif(S',R)}$	8.43	10.36	12.73	15.38	18.19	21.10	24.06	27.05
$\Delta_{dif(S,R')}$	21.88	24.81	27.80	30.80	33.80	36.81	39.82	42.83
$\Delta_{ground(S,O)}$	-2.11	-2.02	-1.94	-1.90	-1.87	-1.86	-1.85	-1.84
$\Delta_{ground(O,R)}$	-0.55	-0.47	-0.42	-0.39	-0.38	-0.37	-0.37	-0.37
A_{dif}	4.48	6.16	8.30	10.78	13.50	16.36	19.29	22.26
$A_{ground(S,R)}$	-	-	-	-	-	-	-	-
$A_{boundary,H}$	**4.48**	**6.16**	**8.30**	**10.78**	**13.50**	**16.36**	**19.29**	**22.26**

Table 5.3.15-11: Unweighted level for propagation in the vertical plane (Hom) (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	
L_W in dB	93	93	93	93	93	93	93	93	
α_{atm}	0.1	0.4	1.0	1.9	3.7	9.7	32.8	116.9	
A_{atm} in dB	0.00	0.01	0.03	0.06	0.11	0.29	0.97	3.45	
A_{div} in dB	40.41	40.41	40.41	40.41	40.41	40.41	40.41	40.41	
$A_{boundary,H}$ in dB	4.49	6.17	8.30	10.79	13.51	16.37	19.30	22.27	
L_H in dB	**48.10**	**46.41**	**44.26**	**41.74**	**38.97**	**35.94**	**32.33**	**26.87**	**52.14**

Table 5.3.15-12: Unweighted level for propagation in the vertical plane (Fav) (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000
L_W in dB	93	93	93	93	93	93	93	93
α_{atm}	0.1	0.4	1.0	1.9	3.7	9.7	32.8	116.9
A_{atm} in dB	0.00	0.01	0.03	0.06	0.11	0.29	0.97	3.45
A_{div} in dB	40.41	40.41	40.41	40.41	40.41	40.41	40.41	40.41
$A_{boundary,F}$ in dB	4.48	6.16	8.30	10.78	13.50	16.36	19.29	22.26
L_F in dB	**48.10**	**46.42**	**44.26**	**41.75**	**38.98**	**35.95**	**32.33**	**26.88**

Table 5.3.15-13: Ground attenuation for lateral propagation (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000
lateral right								
w hom	0.00	0.00	0.00	0.00	0.01	0.04	0.23	1.23
Cf hom	19.57	19.60	19.73	20.34	22.18	21.49	9.40	1.20
A ground-right hom	**-2.40**	**-2.40**	**-2.40**	**-2.40**	**-2.40**	**-2.40**	**-2.40**	**-2.40**
w fav	0.00	0.00	0.00	0.00	0.01	0.03	0.18	0.98
Cf fav	19.57	19.59	19.70	20.20	21.86	22.22	11.29	1.67
A ground-right fav	**-2.40**	**-2.40**	**-2.40**	**-2.40**	**-2.40**	**-2.40**	**-2.40**	**-2.40**
Lateral left								
w hom	0.00	0.00	0.00	0.00	0.01	0.04	0.23	1.22
Cf hom	22.09	22.12	22.28	23.04	25.19	23.72	9.58	1.15
A ground- left hom	**-2.40**	**-2.40**	**-2.40**	**-2.40**	**-2.40**	**-2.40**	**-2.40**	**-2.40**
w fav	0.00	0.00	0.00	0.00	0.01	0.03	0.16	0.87
Cf fav	22.09	22.11	22.23	22.79	24.66	25.08	12.76	1.88
A ground- left Fav	**-2.40**	**-2.40**	**-2.40**	**-2.40**	**-2.40**	**-2.40**	**-2.40**	**-2.40**

Table 5.3.15-14: Calculation of the unweighted partial level for the right detour (Hom) (Source: Umweltbundesamt [9])

Lateral right H									
Frequency (Hz)-->	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	
L_W in dB	93	93	93	93	93	93	93	93	
α-atm(10°,70%)	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.00	0.01	0.03	0.06	0.11	0.29	0.98	3.48	
A_{div} in dB	40.41	40.41	40.41	40.41	40.41	40.41	40.41	40.41	
$A_{ground,H}$ in dB	-2.40	-2.40	-2.40	-2.40	-2.40	-2.40	-2.40	-2.40	
$\Delta_{dif,H}$ in dB	6.76	8.13	10.15	13.04	17.02	21.28	24.93	28.14	
A_H in dB	44.77	46.15	48.19	51.11	55.14	59.58	63.91	69.63	**Total**
L_H in dB	**48.23**	**46.85**	**44.81**	**41.89**	**37.86**	**33.42**	**29.09**	**23.37**	**52.31**

Table 5.3.15-15: Calculation of the unweighted partial level for the right detour (Fav) (Source: Umweltbundesamt [9])

Lateral right F									
Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	
L_W in dB	93	93	93	93	93	93	93	93	
α-atm(10°,70%)	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.00	0.01	0.03	0.06	0.11	0.29	0.98	3.48	
A_{div} in dB	40.41	40.41	40.41	40.41	40.41	40.41	40.41	40.41	
$A_{ground,F}$ in dB	-2.40	-2.40	-2.40	-2.40	-2.40	-2.40	-2.40	-2.40	
$\Delta_{dif,F}$ in dB	6.76	8.13	10.15	13.04	17.02	21.28	24.93	28.14	
A_F in dB	44.77	46.15	48.19	51.11	55.14	59.58	63.91	69.63	**Total**
L_F in dB	**48.23**	**46.85**	**44.81**	**41.89**	**37.86**	**33.42**	**29.09**	**23.37**	**52.31**

Table 5.3.15-16: Calculation of the unweighted partial level for the left detour (Hom) (Source: Umweltbundesamt [9])

Lateral left H									
Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	
L_W in dB	93	93	93	93	93	93	93	93	
α-atm(10°,70%)	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.00	0.01	0.03	0.06	0.11	0.30	1.02	3.65	
A_{div} in dB	40.41	40.41	40.41	40.41	40.41	40.41	40.41	40.41	
$A_{ground,H}$ in dB	-2.40	-2.40	-2.40	-2.40	-2.40	-2.40	-2.40	-2.40	
$\Delta_{dif,H}$ in dB	11.85	14.39	17.19	20.19	23.58	27.70	32.24	36.23	
A_H in dB	49.86	52.41	55.23	58.26	61.70	66.01	71.27	77.88	**Total**
L_H in dB	**43.14**	**40.59**	**37.77**	**34.74**	**31.30**	**26.99**	**21.73**	**15.12**	**46.34**

Table 5.3.15-17: Calculation of the unweighted partial level for the left detour (Fav) (Source: Umweltbundesamt [9])

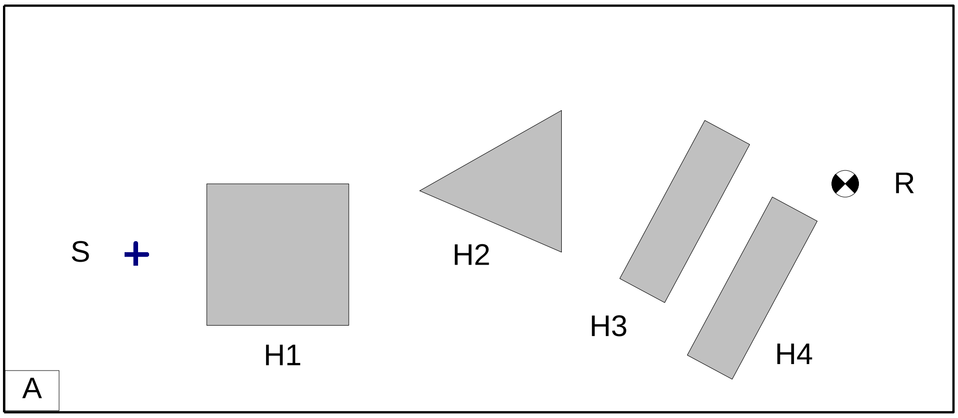
Lateral left F									
Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	
L_W in dB	93	93	93	93	93	93	93	93	
α-atm(10°,70%)	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.00	0.01	0.03	0.06	0.11	0.30	1.02	3.65	
A_{div} in dB	40.41	40.41	40.41	40.41	40.41	40.41	40.41	40.41	
$A_{ground,F}$ in dB	-2.40	-2.40	-2.40	-2.40	-2.40	-2.40	-2.40	-2.40	
$\Delta_{dif,F}$ in dB	11.85	14.39	17.19	20.19	23.58	27.70	32.24	36.23	
A_F in dB	49.86	52.41	55.23	58.26	61.70	66.01	71.27	77.88	**Total**
L_F in dB	**43.14**	**40.59**	**37.77**	**34.74**	**31.30**	**26.99**	**21.73**	**15.12**	**46.34**

Table 5.3.15-18: Partial and total levels for the three propagation paths (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	
L_A in dB top	21.90	30.31	35.66	38.55	38.98	37.14	33.33	25.77	
L_A in dB right	22.03	30.75	36.21	38.69	37.86	34.62	30.09	22.27	
L_A in dB left	16.94	24.49	29.17	31.54	31.30	28.19	22.73	14.02	**Total**
L_A in dB	**25.61**	**34.06**	**39.39**	**42.04**	**41.86**	**39.42**	**35.26**	**27.57**	**47.45**

5.3.16 TC 15 - Four houses on level ground with constant ground factor G

Figure 5.3.16-1: Four houses on level ground (S source, R place of immission, A area) (Source: Umweltbundesamt [9])



The ground level is z=0. The ground factor G in area A is 0.5 (constant). With this scenario the criteria should be verified, whether a house is to be used for the calculation of the side diffraction and which edges determine the individual paths.

Table 5.3.16-1: Coordinates of source S and point of immission R (Source: Umweltbundesamt [9])

Point	x (m)	Y (m)	z (abs) (m)
S	50	10	1
R	100	15	5

Table 5.3.16-2: Coordinates of the houses (Source: Umweltbundesamt [9])

Building No.	Corner No.	x (m)	y (m)	z (abs) (m)
1	1	55.00	5.00	8
1	2	65.00	5.00	8
1	3	65.00	15.00	8
1	4	55.00	15.00	8
2	5	70.00	14.50	12
2	6	80.00	10.17	12
2	7	80.00	20.17	12
3	8	90.11	19.48	10
3	9	93.27	17.78	10
3	10	87.27	6.61	10
3	11	84.11	8.31	10
4	12	94.86	14.06	10
4	13	98.02	12.37	10
4	14	92.03	1.2	10
4	15	88.86	2.9	10

Table 5.3.16-3: z-height profile along the propagation path (Source: Umweltbundesamt [9])

z-Profile S - R		
No.	u (m)	v (m)
1	0.00	0.00
2	5.02	0.00
3	5.02	8.00
4	15.07	8.00
5	15.08	0.00
6	24.81	0.00
7	24.81	12.00
8	30.15	12.00
9	30.15	0.00
10	37.19	0.00
11	37.19	10.00
12	41.52	10.00
13	41.52	0.00
14	50.25	0.00

Table 5.3.16-4: Mean ground levels MGL and average ground factors (Hom) (Source: Umweltbundesamt [9])

Parameters	S -> O1	On -> R	S->R ri	S->R le
a (MGL)	0.00	0.00	0.08	0.00
b (MGL)	0.00	0.00	-1.19	0.00
z1	1.00	10.00	2.18	1.00
z2	8.00	5.00	2.01	5.00
dp	5.02	8.73	54.80	53.60
Gpath	0.50	0.50	0.46	0.50
G'path	0.50		0.48	0.50

Table 5.3.16-5: Coordinates of the mirror points (Hom) (Source: Umweltbundesamt [9])

Mirror points	u	v
S' (S -> O)	0.00	-1.00
R' (O -> R)	50.25	-5.00

Table 5.3.16-6: Detour calculation due to sound barriers (Source: Umweltbundesamt [9])

Para-meters	S -> R		S '-> R		S -> R'		Lateral right		Lateral left	
	Hom	Fav	Hom	Fav	Hom	Fav	Hom	Fav	Hom	Fav
KA1	3	3	3	3	3	3	-	-	-	-
KA2	12	12	12	12	12	12	-	-	-	-
dir	50.41	50.41	50.61	50.61	50.61	50.61	50.41	50.41	50.41	50.41
dss	8.62	8.62	10.31	10.31	8.62	8.62	7.08	7.08	7.09	7.09
dsr	10.06	10.06	10.06	10.06	17.36	17.36	15.29	15.29	10.88	10.88
e	37.07	37.07	37.07	37.07	37.07	37.07	32.43	32.43	35.77	35.77
z	5.34	5.33	6.83	6.83	12.43	12.43	4.39	4.39	3.34	3.34

Table 5.3.16-7: Calculation of A boundary (Hom) (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000
$\Delta_{dif(S,R)}$	18.64	22.86	26.49	29.68	32.74	35.76	38.77	41.78
$A_{ground,(S,O)}$	-1.50	-1.50	-1.50	-1.50	-1.50	-1.50	-1.50	-1.50
$A_{ground,(O,R)}$	-1.50	-1.50	-1.50	-1.50	-1.50	-1.50	-1.50	-1.50
$\Delta_{dif(S',R)}$	19.67	23.92	27.55	30.75	33.81	36.83	39.84	42.85
$\Delta_{dif(S,R')}$	22.21	26.50	30.14	33.35	36.41	39.43	42.44	45.45
$\Delta_{ground(S,O)}$	-1.34	-1.34	-1.34	-1.34	-1.34	-1.34	-1.34	-1.34
$\Delta_{ground(O,R)}$	-1.02	-1.02	-1.01	-1.01	-1.01	-1.01	-1.01	-1.01
A_{dif}	16.27	20.51	22.65	22.65	22.65	22.65	22.65	22.65
$A_{ground(S,R)}$	-	-	-	-	-	-	-	-
$A_{boundary,H}$	**16.27**	**20.51**	**22.65**	**22.65**	**22.65**	**22.65**	**22.65**	**22.65**

Table 5.3.16-8: Spectral intermediate and final results for the vertical propagation plane (Source: Umweltbundesamt [9])

Frequency (Hz)-->	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	
L_W in dB	93	93	93	93	93	93	93	93	
α_{atm}	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.01	0.02	0.05	0.10	0.18	0.49	1.65	5.89	
A_{div} in dB	45.05	45.05	45.05	45.05	45.05	45.05	45.05	45.05	
$A_{boundary,H}$ in dB	16.27	20.51	22.65	22.65	22.65	22.65	22.65	22.65	
$A_{boundary,F}$ in dB	16.27	20.50	22.65	22.65	22.65	22.65	22.65	22.65	**Total**
L_H in dB	31.67	27.42	25.25	25.20	25.12	24.81	23.65	19.41	35.60
L_F in dB	31.67	27.43	25.25	25.20	25.12	24.81	23.65	19.41	35.61
L in dB	31.67	27.42	25.25	25.20	25.12	24.81	23.65	19.41	35.61
A-weighting dB	-26.2	-16.1	-8.6	-3.2	0.0	1.2	1.0	-1.1	
L_A^a in dB	**5.47**	**11.32**	**16.65**	**22.00**	**25.12**	**26.01**	**24.65**	**18.31**	**31.16**

Table 5.3.16-9: Ground attenuation for lateral propagation (Source: Umweltbundesamt [9])

Frequency (Hz)-->	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
lateral right								
w hom	0.00	0.00	0.00	0.01	0.07	0.37	1.92	9.32
Cf hom	55.20	56.69	61.53	61.63	29.93	4.28	0.52	0.11
A ground-right hom	**-1.56**	**-1.56**	**-1.32**	**-1.23**	**-1.56**	**-1.56**	**-1.56**	**-1.56**
w fav	0.00	0.00	0.00	0.01	0.06	0.33	1.69	8.30
Cf fav	55.15	56.48	61.02	62.61	33.11	5.18	0.59	0.12
A ground-right fav	**-1.56**	**-1.30**	**-1.08**	**-1.56**	**-1.56**	**-1.56**	**-1.56**	**-1.56**
lateral left								
w hom	0.00	0.00	0.00	0.01	0.08	0.41	2.10	10.13
Cf hom	54.02	55.58	60.47	59.60	27.53	3.75	0.47	0.10
A ground- left hom	**-1.50**	**-1.50**	**-1.50**	**-1.50**	**-1.50**	**-1.50**	**-1.50**	**-1.50**
w fav	0.00	0.00	0.00	0.01	0.08	0.41	2.10	10.13
Cf fav	54.02	55.58	60.47	59.60	27.53	3.75	0.47	0.10
A ground- left Fav	**-1.50**	**-1.50**	**-1.50**	**-1.50**	**-1.50**	**-1.50**	**-1.50**	**-1.50**

Table 5.3.16-10: Calculation of the unweighted partial level for the right detour (Hom) (Source: Umweltbundesamt [9])

Lateral right H									
Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	
L_W in dB	93	93	93	93	93	93	93	93	
α-atm(10°,70%)	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.01	0.02	0.06	0.11	0.20	0.53	1.80	6.41	
A_{div} in dB	45.05	45.05	45.05	45.05	45.05	45.05	45.05	45.05	
$A_{ground,H}$ in dB	-1.56	-1.56	-1.32	-1.23	-1.56	-1.56	-1.56	-1.56	
$\Delta_{dif,H}$ in dB	17.54	21.82	25.57	28.82	31.89	34.91	37.92	40.93	
A_H in dB	61.03	65.34	69.36	72.74	75.58	78.93	83.21	90.83	**Total**
L_H in dB	**31.97**	**27.66**	**23.64**	**20.26**	**17.42**	**14.07**	**9.79**	**2.17**	**34.13**

Table 5.3.16-11: Calculation of the unweighted partial level for the right detour (Fav) (Source: Umweltbundesamt [9])

Lateral right F									
Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	
L_W in dB	93	93	93	93	93	93	93	93	
α-atm(10°,70%)	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.01	0.02	0.06	0.11	0.20	0.53	1.80	6.41	
A_{div} in dB	45.05	45.05	45.05	45.05	45.05	45.05	45.05	45.05	
$A_{ground,F}$ in dB	-1.56	-1.30	-1.08	-1.56	-1.56	-1.56	-1.56	-1.56	
$\Delta_{dif,F}$ in dB	17.54	21.82	25.57	28.82	31.89	34.91	37.92	40.93	
A_F in dB	61.03	65.59	69.60	72.41	75.58	78.93	83.21	90.83	**Total**
L_F in dB	**31.97**	**27.41**	**23.40**	**20.59**	**17.42**	**14.07**	**9.79**	**2.17**	**34.06**

Table 5.3.16-12: Calculation of the unweighted partial level for the left detour (Hom) (Source: Umweltbundesamt [9])

Lateral left H									
Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	
L_W in dB	93	93	93	93	93	93	93	93	
α-atm(10°,70%)	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.01	0.02	0.06	0.10	0.20	0.52	1.76	6.28	
A_{div} in dB	45.05	45.05	45.05	45.05	45.05	45.05	45.05	45.05	
$A_{ground,H}$ in dB	-1.50	-1.50	-1.50	-1.50	-1.50	-1.50	-1.50	-1.50	
$\Delta_{dif,H}$ in dB	16.63	20.81	24.44	27.65	30.70	33.72	36.73	39.74	
A_H in dB	60.19	64.38	68.05	71.30	74.45	77.79	82.04	89.57	**Total**
L_H in dB	**32.81**	**28.62**	**24.95**	**21.70**	**18.55**	**15.21**	**10.96**	**3.43**	**35.08**

Table 5.3.16-13: Calculation of the unweighted partial level for the left detour (Fav) (Source: Umweltbundesamt [9])

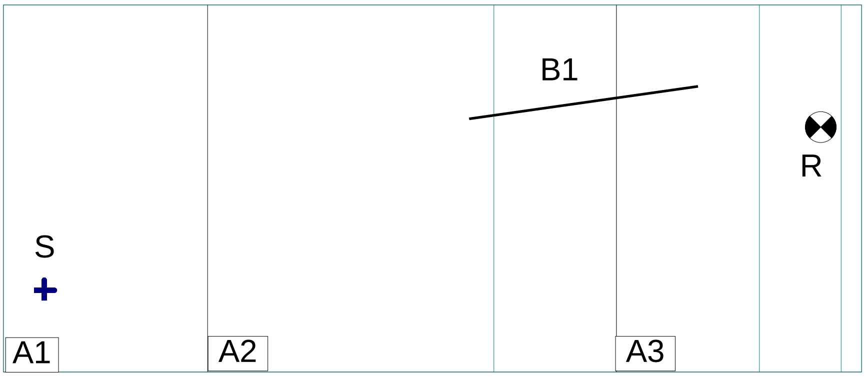
Lateral left F									
Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	
L_W in dB	93	93	93	93	93	93	93	93	
α-atm(10°,70%)	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.01	0.02	0.06	0.10	0.20	0.52	1.76	6.28	
A_{div} in dB	45.05	45.05	45.05	45.05	45.05	45.05	45.05	45.05	
$A_{ground,F}$ in dB	-1.50	-1.50	-1.50	-1.50	-1.50	-1.50	-1.50	-1.50	
$\Delta_{dif,F}$ in dB	16.63	20.81	24.44	27.65	30.70	33.72	36.73	39.74	
A_F in dB	60.19	64.38	68.05	71.30	74.45	77.79	82.04	89.57	**Total**
L_F in dB	**32.81**	**28.62**	**24.95**	**21.70**	**18.55**	**15.21**	**10.96**	**3.43**	**35.08**

Table 5.3.16-14: Partial and total levels for the three propagation paths (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	
L_A in dB top	5.47	11.32	16.65	22.00	25.12	26.01	24.65	18.31	
L_A in dB right	5.77	11.44	14.92	17.22	17.42	15.27	10.79	1.07	
L_A in dB left	6.61	12.52	16.35	18.50	18.55	16.41	11.96	2.33	**Total**
L_A in dB	**10.75**	**16.57**	**20.81**	**24.51**	**26.55**	**26.78**	**25.04**	**18.50**	**32.50**

5.3.17 TC 16 - Reflective wall on ground with varying heights and ground factors G

Figure 5.3.17-1: Wall B1 in reflection condition (S source, R immission point, B wall, A1 area with G=0.9, A2 area with G=0.5, A3 area with G=0.2) (Source: Umweltbundesamt [9])



Checking the reflection calculation. With favorable conditions, due to the small distance of the reflection point in the lowest frequency band 63 Hz, there is a weakening of the reflection due to retro diffraction.

Table 5.3.17-1: Coordinates of source S and point of immission R (Source: Umweltbundesamt [9])

Point	x (m)	y (m)	z (abs) (m)
S	10	10	1
R	200	50	14

Table 5.3.17-2: Contour lines to describe the ground model (Source: Umweltbundesamt [9])

No.	x1 (m)	y1 (m)	z1 (m)	x2 (m)	y2 (m)	z2 (m)
1	185	-10	10	205	-10	10
2	205	-10	10	205	80	10
3	205	80	10	185	80	10
4	0	80	0	0	-10	0

Table 5.3.17-3: Rectangular areas with a given ground index G (Source: Umweltbundesamt [9])

G	x (m)		y (m)	
	min	max	min	max
0.9	0.00	50.00	-10.00	80.00
0.5	50.00	150.00	-10.00	80.00
0.2	150.00	210.00	-10.00	80.00

Table 5.3.17-4: Coordinates of sound barriers (upper edge) (Source: Umweltbundesamt [9])

Barrier No.	x (m)	y (m)	z (m)
1	114.00	52.00	15.00
1	170.00	60.00	15.00

Table 5.3.17-5: Absorption coefficient of the reflecting surface (Source: Umweltbundesamt [9])

F (Hz)	63	125	250	500	1000	2000	4000	8000
$\alpha_{Surface}$	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.5

Table 5.3.17-6: z-height profile along the propagation path (Source: Umweltbundesamt [9])

z-Profile S - R		
No.	u (m)	v (m)
1	0.00	0.00
2	112.41	0.00
3	178.84	10.00
4	194.16	10.00

Table 5.3.17-7: G-profile on the propagation path (Source: Umweltbundesamt [9])

G-Profile S -> R			
from (m)	to (m)	length (m)	G
0.00	40.88	40.88	0.9
40.88	143.07	102.19	0.5
143.07	194.16	51.09	0.2

Table 5.3.17-8: Mean ground levels MGL and average ground factors (Hom) (Source: Umweltbundesamt [9])

Parameters	S -> R
a (MGL)	0.05
b (MGL)	-2.83
z1	3.83
z2	6.16
dp	194.59
Gpath	0.51
G'path	0.64

Table 5.3.17-9: Coordinates of the mirror points (Hom) (Source: Umweltbundesamt [9])

Mirror points	u	v
S' (S -> R)	0.42	-6.64
R' (S -> R)	194.84	1.70

Table 5.3.17-10: Ground attenuation (relevant if no diffraction) (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000
w (H)	1,6E-04	8,7E-04	4,8E-03	0.03	0.14	0.75	3.70	16.77
C_f (H)	203.37	222.35	207.73	82.09	9.63	1.33	0.27	0.06
$A_{ground,H}$	**-1.07**	**-1.07**	**-1.07**	**-1.07**	**-1.07**	**-1.07**	**-1.07**	**-1.07**
w (F)	0.00	0.00	0.00	0.01	0.08	0.42	2.16	10.35
C_f (F)	199.73	214.27	225.54	131.93	22.89	2.42	0.46	0.10
$A_{ground,F}$	**-1.07**	**-1.07**	**-1.07**	**-1.07**	**-1.07**	**-1.07**	**-1.07**	**-1.07**

Table 5.3.17-11: Spectral intermediate and final results for the vertical propagation plane (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	
L_W in dB	93	93	93	93	93	93	93	93	
α_{atm}	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.02	0.08	0.20	0.38	0.71	1.88	6.38	22.75	
A_{div} in dB	56.78	56.78	56.78	56.78	56.78	56.78	56.78	56.78	
$A_{boundary,H}$ in dB	-1.07	-1.07	-1.07	-1.07	-1.07	-1.07	-1.07	-1.07	
$A_{boundary,F}$ in dB	-1.07	-1.07	-1.07	-1.07	-1.07	-1.07	-1.07	-1.07	**Total**
L_H in dB	37.26	37.21	37.08	36.91	36.57	35.41	30.91	14.54	44.75
L_F in dB	37.26	37.21	37.08	36.91	36.57	35.41	30.91	14.54	44.75
L in dB	37.26	37.21	37.08	36.91	36.57	35.41	30.91	14.54	44.75
A-weighting dB	-26.2	-16.1	-8.6	-3.2	0.0	1.2	1.0	-1.1	
$L_A{}^a$ in dB	**11.06**	**21.11**	**28.48**	**33.71**	**36.57**	**36.61**	**31.91**	**13.44**	**41.43**

Table 5.3.17-12: z-height profile along the reflected beam - reflection (Source: Umweltbundesamt [9])

z-Height profile S '- R		
Pkt	u	z
1	0.00	0.00
2	117.12	0.00
3	129.75	1.82
4	129.75	1.82
5	129.75	1.82
6	183.01	10.00
7	198.04	10.00

Table 5.3.17-13: G-profile along the reflected beam - reflection (Source: Umweltbundesamt [9])

G-Profile			
from	to	length	G
0.00	42.59	42.59	0.9
42.59	42.59	0.00	0.9
42.59	129.75	87.16	0.5
129.75	147.93	18.18	0.5
147.93	147.93	0.00	0.5
147.93	198.04	50.11	0.2

Table 5.3.17-14: Mean ground levels MGL and average ground factors (Hom) - Reflection (Source: Umweltbundesamt [9])

Parameters	S -> R
a (MGL)	0.05
b (MGL)	-2.80
z1	3.80
z2	6.37
dp	198.45
Gpath	0.51
G'path	0.65

Table 5.3.17-15: Coordinates of the mirror points (Hom) - Reflection (Source: Umweltbundesamt [9])

Mirror points	u	v
S' (S -> R)	0.40	-6.58
R' (S -> R)	198.71	1.27

Table 5.3.17-16: Ground attenuation (relevant if no diffraction) - Reflection (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000
w (H)	1,6E-04	8,7E-04	4,9E-03	0.03	0.14	0.76	3.73	16.91
C_f (H)	207.64	227.15	210.40	81.36	9.40	1.32	0.27	0.06
$A_{ground,H}$	**-1.06**	**-1.06**	**-1.06**	**-1.06**	**-1.06**	**-1.06**	**-1.06**	**-1.06**
w (F)	0.00	0.00	0.00	0.01	0.08	0.43	2.20	10.56
C_f (F)	203.91	219.10	229.36	130.79	21.96	2.36	0.45	0.09
$A_{ground,F}$	**-1.06**	**-1.06**	**-1.06**	**-1.06**	**-1.06**	**-1.06**	**-1.06**	**-1.06**

Table 5.3.17-17: Calculation of the unweighted partial level for the reflected beam (Hom) - reflection (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	
L_W in dB	93	93	93	93	93	93	93	93	
dL_{abs}	-0.46	-0.97	-1.55	-2.22	-3.01	-3.98	-5.23	-3.01	
$dL_{retrodif}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
L_W in dB	**92.54**	**92.03**	**91.45**	**90.78**	**89.99**	**89.02**	**87.77**	**89.99**	
α_{atm}	0.1	0.4	1.0	1.9	3.7	9.7	32.8	116.9	
A_{atm} in dB	0.02	0.08	0.21	0.38	0.73	1.92	6.50	23.20	
A_{div} in dB	56.95	56.95	56.95	56.95	56.95	56.95	56.95	56.95	
$A_{boundary,H}$ in dB	-1.06	-1.06	-1.06	-1.06	-1.06	-1.06	-1.06	-1.06	**Total**
L_H in dB	36.63	36.06	35.35	34.51	33.37	31.21	25.37	10.90	42.73

Table 5.3.17-18: Calculation of the unweighted partial level for the reflected beam (Fav) - Reflection (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	
L_W in dB	93	93	93	93	93	93	93	93	
dL_{abs}	-0.46	-0.97	-1.55	-2.22	-3.01	-3.98	-5.23	-3.01	
$dL_{retrodif}$	0.68	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
L_W in dB	**91.86**	**92.03**	**91.45**	**90.78**	**89.99**	**89.02**	**87.77**	**89.99**	
α_{atm}	0.1	0.4	1.0	1.9	3.7	9.7	32.8	116.9	
A_{atm} in dB	0.02	0.08	0.21	0.38	0.73	1.92	6.50	23.20	
A_{div} in dB	56.95	56.95	56.95	56.95	56.95	56.95	56.95	56.95	
$A_{boundary,F}$ in dB	-1.06	-1.06	-1.06	-1.06	-1.06	-1.06	-1.06	-1.06	**Total**
L_F in dB	35.94	36.06	35.35	34.51	33.37	31.21	25.37	10.90	42.57

Table 5.3.17-19: Calculation of the A-weighted partial level for the reflected beam (Hom and Fav) - Reflection (Source: Umweltbundesamt [9])

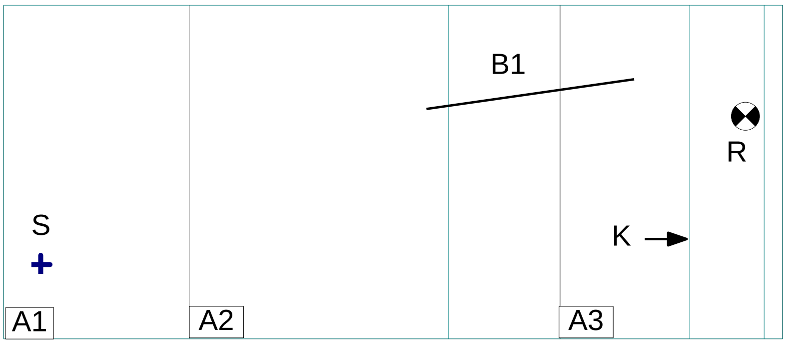
Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	
L_W in dB	93	93	93	93	93	93	93	93	
$dL_{abs,H}$	-0.46	-0.97	-1.55	-2.22	-3.01	-3.98	-5.23	-3.01	
$dL_{retrodif,H}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
$L_{W,H}$ in dB	**92.54**	**92.03**	**91.45**	**90.78**	**89.99**	**89.02**	**87.77**	**89.99**	
$\alpha_{atm,H}$	0.1	0.4	1.0	1.9	3.7	9.7	32.8	116.9	
$A_{atm,H}$ in dB	0.02	0.08	0.21	0.38	0.73	1.92	6.50	23.20	
A_{div} in dB	56.95	56.95	56.95	56.95	56.95	56.95	56.95	56.95	
$A_{boundary,H}$ in dB	-1.06	-1.06	-1.06	-1.06	-1.06	-1.06	-1.06	-1.06	
L_H in dB	36.63	36.06	35.35	34.51	33.37	31.21	25.37	10.90	
$dL_{abs,F}$	-0.46	-0.97	-1.55	-2.22	-3.01	-3.98	-5.23	-3.01	
$dL_{retrodif,F}$	0.68	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
$L_{W,F}$ in dB	91.86	92.03	91.45	90.78	89.99	89.02	87.77	89.99	
$\alpha_{atm,F}$	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
$A_{atm,F}$ in dB	0.02	0.08	0.21	0.38	0.73	1.92	6.50	23.20	
A_{div} in dB	56.95	56.95	56.95	56.95	56.95	56.95	56.95	56.95	
$A_{boundary,F}$ in dB	-1.06	-1.06	-1.06	-1.06	-1.06	-1.06	-1.06	-1.06	
L_F in dB	35.94	36.06	35.35	34.51	33.37	31.21	25.37	10.90	
L in dB	36.30	36.06	35.35	34.51	33.37	31.21	25.37	10.90	
A-correction in dB	-26.2	-16.1	-8.6	-3.2	0.0	1.2	1.0	-1.1	**Total**
L_A in dB	**10.10**	**19.96**	**26.75**	**31.31**	**33.37**	**32.41**	**26.37**	**9.80**	**37.99**

Table 5.3.17-20: Calculation of the A-weighted total level (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	Total
LA in dB direct sound	11.06	21.11	28.48	33.71	36.57	36.61	31.91	13.44	41.43
LA in dB reflection	10.10	19.96	26.75	31.31	33.37	32.41	26.37	9.80	37.99
LA in dB	**13.62**	**23.58**	**30.71**	**35.68**	**38.27**	**38.01**	**32.98**	**15.00**	**43.05**

5.3.18 TC 17 - Reflecting wall on ground with varying heights and ground factors G and partially screened floor edge

Figure 5.3.18-1: Wall B1 in reflection condition (S source, R immission point, A1 area with G=0.9, A2 area with G=0.5, A3 area with G=0.2, K partially screened edge) (Source: Umweltbundesamt [9])



All conditions and input data are identical to TC 16 except for the height of the immission point. This new height of the immission point R is 11.5 m absolute.

Due to the changed height of the immission point, screening of the ground edge K is also relevant. However, only the lower frequency bands – for homogeneous conditions up to 500 Hz and for favorable conditions up to 250 Hz - theoretically provide screening. This is discarded due to the Rayleigh Criterion for the frequency bands up to 250 Hz at homogeneous conditions and for 63 Hz at favorable conditions, whereby the sound barrier leads to a level reduction for homogeneous bands only in the frequency band 500 Hz and for favorable bands 125 Hz and 250 Hz.

Table 5.3.18-1: z-height profile along the propagation path (Source: Umweltbundesamt [9])

z-Profile S - R		
No.	u (m)	v (m)
1	0.00	0.00
2	112.41	0.00
3	178.84	10.00
4	194.16	10.00

Table 5.3.18-2: Ground attenuation (relevant if no diffraction) (Source: Umweltbundesamt [9])

Frequency (Hz)-->	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
w (H)	1,1E-04	6,0E-04	3,4E-03	-	-	0.53	2.70	12.70
C_f (H)	200.89	217.45	220.41	-	-	1.88	0.37	0.08
$A_{ground,H}$	**-1.32**	**-1.32**	**-1.32**	**-**	**-**	**-1.32**	**-1.32**	**-1.32**
w (F)	0.00	0.00	0.00	0.01	0.08	0.42	2.16	10.35
C_f (F)	199.59	214.11	225.39	131.90	22.89	2.42	0.46	0.10
$A_{ground,F}$	**-1.32**	**-1.32**	**-1.29**	**-1.05**	**-1.32**	**-1.32**	**-1.32**	**-1.32**

Table 5.3.18-3: Calculation of A boundary (Hom) (Source: Umweltbundesamt [9])

Frequency (Hz)-->	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
$\Delta_{dif(S,R)}$	0.00	0.00	0.00	3.16	0.56	0.00	0.00	0.00
$A_{ground,(S,O)}$	-	-	-	2.74	-1.21	-	-	-
$A_{ground,(O,R)}$	-	-	-	-2.40	-2.40	-	-	-
$\Delta_{dif(S',R)}$	-	-	-	4.71	4.65	-	-	-
$\Delta_{dif(S,R')}$	-	-	-	10.83	13.26	-	-	-
$\Delta_{ground(S,O)}$	-	-	-	2.23	-0.77	-	-	-
$\Delta_{ground(O,R)}$	-	-	-	-1.07	-0.62	-	-	-
A_{dif}	-	-	-	4.31	-0.83	-	-	-
$A_{ground(S,R)}$	-1.32	-1.32	-1.32	-	-	-1.32	-1.32	-1.32
$A_{boundary,H}$	**-1.32**	**-1.32**	**-1.32**	**4.31**	**-0.83**	**-1.32**	**-1.32**	**-1.32**

Table 5.3.18-4: Spectral intermediate and final results for the vertical propagation plane (Source: Umweltbundesamt [9])

Frequency (Hz)-->	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	
L_W in dB	93	93	93	93	93	93	93	93	
α_{atm}	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.02	0.08	0.20	0.37	0.71	1.88	6.37	22.73	
A_{div} in dB	56.78	56.78	56.78	56.78	56.78	56.78	56.78	56.78	
$A_{boundary,H}$ in dB	-1.32	-1.32	-1.32	4.31	-0.83	-1.32	-1.32	-1.32	
$A_{boundary,F}$ in dB	-1.32	-1.32	-1.29	-1.05	-1.32	-1.32	-1.32	-1.32	**Total**
L_H in dB	37.53	37.47	37.35	31.54	36.34	35.67	31.18	14.82	44.38
L_F in dB	37.53	37.47	37.31	36.89	36.84	35.67	31.18	14.82	44.97
L in dB	37.53	37.47	37.33	34.99	36.60	35.67	31.18	14.82	44.68
A-weighting dB	-26.2	-16.1	-8.6	-3.2	0.0	1.2	1.0	-1.1	
L_A^a in dB	**11.33**	**21.37**	**28.73**	**31.79**	**36.60**	**36.87**	**32.18**	**13.72**	**41.31**

Table 5.3.18-5: Ground attenuation (relevant if no diffraction) - Reflection (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000
w (H)	1,1E-04	6,2E-04	3,4E-03	-	0.10	0.55	2.77	12.97
C_f (H)	205.15	222.41	223.52	-	15.34	1.83	0.36	0.08
$A_{ground,H}$	**-1.31**	**-1.31**	**-1.31**	**-**	**-1.31**	**-1.31**	**-1.31**	**-1.31**
w (F)	0.00	0.00	0.00	0.01	0.08	0.43	2.20	10.56
C_f (F)	203.77	218.95	229.22	130.76	21.97	2.36	0.45	0.09
$A_{ground,F}$	**-1.31**	**-1.31**	**-1.26**	**-1.28**	**-1.31**	**-1.31**	**-1.31**	**-1.31**

Table 5.3.18-6: Calculation of A boundary (Hom) – Reflection (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000
$\Delta_{dif(S,R)}$	0.00	0.00	0.00	2.92	0.00	0.00	0.00	0.00
$A_{ground,(S,O)}$	-	-	-	2.66	-	-	-	-
$A_{ground,(O,R)}$	-	-	-	-2.40	-	-	-	-
$\Delta_{dif(S',R)}$	-	-	-	4.65	-	-	-	-
$\Delta_{dif(S,R')}$	-	-	-	10.81	-	-	-	-
$\Delta_{ground(S,O)}$	-	-	-	2.12	-	-	-	-
$\Delta_{ground(O,R)}$	-	-	-	-1.05	-	-	-	-
A_{dif}	-	-	-	3.99	-	-	-	-
$A_{ground(S,R)}$	-1.31	-1.31	-1.31	-	-1.31	-1.31	-1.31	-1.31
$A_{boundary,H}$	**-1.31**	**-1.31**	**-1.31**	**3.99**	**-1.31**	**-1.31**	**-1.31**	**-1.31**

Table 5.3.18-7: Calculation of the unweighted partial level for the reflected beam (Hom) - reflection (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	
L_W in dB	93	93	93	93	93	93	93	93	
dL_{abs}	-0.46	-0.97	-1.55	-2.22	-3.01	-3.98	-5.23	-3.01	
$dL_{retrodif}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
L_W in dB	**92.54**	**92.03**	**91.45**	**90.78**	**89.99**	**89.02**	**87.77**	**89.99**	
α_{atm}	0.1	0.4	1.0	1.9	3.7	9.7	32.8	116.9	
A_{atm} in dB	0.02	0.08	0.21	0.38	0.73	1.92	6.50	23.18	
A_{div} in dB	56.95	56.95	56.95	56.95	56.95	56.95	56.95	56.95	
$A_{boundary,H}$ in dB	-1.31	-1.31	-1.31	3.99	-1.31	-1.31	-1.31	-1.31	**Total**
L_H in dB	36.88	36.31	35.60	29.46	33.62	31.46	25.63	11.17	42.49

Table 5.3.18-8: Calculation of the unweighted partial level for the reflected beam (Fav) - Reflection (Source: Umweltbundesamt [9])

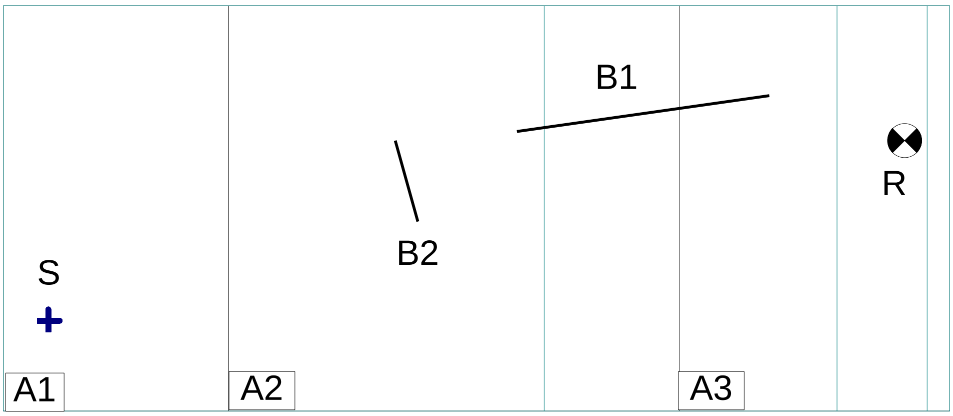
Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	
L_W in dB	93	93	93	93	93	93	93	93	
dL_{abs}	-0.46	-0.97	-1.55	-2.22	-3.01	-3.98	-5.23	-3.01	
$dL_{retrodif}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
L_W in dB	**92.54**	**92.03**	**91.45**	**90.78**	**89.99**	**89.02**	**87.77**	**89.99**	
α_{atm}	0.1	0.4	1.0	1.9	3.7	9.7	32.8	116.9	
A_{atm} in dB	0.02	0.08	0.21	0.38	0.73	1.92	6.50	23.18	
A_{div} in dB	56.95	56.95	56.95	56.95	56.95	56.95	56.95	56.95	
$A_{boundary,F}$ in dB	-1.31	-1.31	-1.26	-1.28	-1.31	-1.31	-1.31	-1.31	**Total**
L_F in dB	36.88	36.31	35.56	34.73	33.62	31.46	25.63	11.17	42.97

Table 5.3.18-9: Calculation of the A-weighted total level (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	Total
LA in dB direct sound	11.33	21.37	28.73	31.79	36.60	36.87	32.18	13.72	41.31
LA in dB reflection	10.68	20.21	26.98	29.65	33.62	32.66	26.63	10.07	37.90
LA in dB	**14.02**	**23.84**	**30.95**	**33.86**	**38.37**	**38.27**	**33.25**	**15.28**	**42.94**

5.3.19 TC 18 - Sound barrier and reflecting wall on ground with varying heights and ground factors G

Figure 5.3.19-1: Walls B1 and B2 (S source, R place of immission, A1 area with G=0.9, A2 area with G=0.5, A3 area with G=0.2) (Source: Umweltbundesamt [9])



Here, sound barrier B2 with a height of 12 m between source S and reflector B1 (height 15 m absolute) is additionally relevant in the reflected beam. By agreement, the height of the beam when "passing" the obstacle should be taken into account when calculating the height of the reflection point for both homogeneous and favorable beams.

Table 5.3.19-1: Coordinates of source S and point of immission R (Source: Umweltbundesamt [9])

Point	x (m)	y (m)	z (abs) (m)
S	10	10	1
R	200	50	12

Table 5.3.19-2: z-height profile along the propagation path (Source: Umweltbundesamt [9])

z-Profile S - R		
No.	u (m)	v (m)
1	0.00	0.00
2	112.41	0.00
3	178.84	10.00
4	194.16	10.00

Table 5.3.19-3: Mean ground levels MGL and average ground factors (Hom) (Source: Umweltbundesamt [9])

Parameters	S -> R
a (MGL)	0.05
b (MGL)	-2.83
z1	3.83
z2	4.16
dp	194.48
Gpath	0.51
G'path	0.58

Table 5.3.19-4: Ground attenuation (relevant if no diffraction) (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000
w (H)	1,2E-04	6,6E-04	3,7E-03	0.02	0.11	0.58	2.94	13.68
C_f (H)	201.47	218.76	217.73	102.89	14.04	1.71	0.34	0.07
$A_{ground,H}$	**-1.26**	**-1.26**	**-1.26**	**2.12**	**-1.26**	**-1.26**	**-1.26**	**-1.26**
w (F)	0.00	0.00	0.00	0.01	0.08	0.42	2.16	10.35
C_f (F)	199.62	214.14	225.42	131.91	22.89	2.42	0.46	0.10
$A_{ground,F}$	**-1.26**	**-1.26**	**-1.26**	**-1.26**	**-1.26**	**-1.26**	**-1.26**	**-1.26**

Table 5.3.19-5: Spectral intermediate and final results for the vertical propagation plane (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	Total
L_W in dB	93	93	93	93	93	93	93	93	
α_{atm}	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.02	0.08	0.20	0.37	0.71	1.88	6.37	22.73	
A_{div} in dB	56.78	56.78	56.78	56.78	56.78	56.78	56.78	56.78	
$A_{boundary,H}$ in dB	-1.26	-1.26	-1.26	2.12	-1.26	-1.26	-1.26	-1.26	
$A_{boundary,F}$ in dB	-1.26	-1.26	-1.26	-1.26	-1.26	-1.26	-1.26	-1.26	
L_H in dB	37.46	37.40	37.28	33.73	36.77	35.60	31.11	14.75	44.55
L_F in dB	37.46	37.40	37.28	37.11	36.77	35.60	31.11	14.75	44.95
L in dB	37.46	37.40	37.28	35.74	36.77	35.60	31.11	14.75	44.75
A-weighting dB	-26.2	-16.1	-8.6	-3.2	0.0	1.2	1.0	-1.1	
$L_A{}^a$ in dB	**11.26**	**21.30**	**28.68**	**32.54**	**36.77**	**36.80**	**32.11**	**13.65**	**41.42**

Table 5.3.19-6: Mean ground levels MGL and average ground factors (Hom) - Reflection (Source: Umweltbundesamt [9])

Parameters	S -> O1	On -> R
a (MGL)	0.00	0.11
b (MGL)	0.00	-12.03
z1	1.00	14.16
z2	12.00	1.29
dp	85.16	112.14
Gpath	0.70	0.37
G'path	0.86	

Table 5.3.19-7: Calculation of A boundary (Hom) – Reflection (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000
$\Delta_{dif(S,R)}$	7.77	9.50	11.71	14.26	17.02	19.90	22.84	25.82
$A_{ground,(S,O)}$	-0.43	-0.43	-0.43	-0.43	-0.43	-0.43	-0.43	-0.43
$A_{ground,(O,R)}$	-1.90	-1.90	-1.90	-1.90	-1.90	-1.90	-1.90	-1.90
$\Delta_{dif(S',R)}$	8.54	10.51	12.90	15.56	18.38	21.30	24.26	27.25
$\Delta_{dif(S,R')}$	8.53	10.49	12.88	15.54	18.36	21.27	24.24	27.22
$\Delta_{ground(S,O)}$	-0.39	-0.38	-0.38	-0.37	-0.37	-0.37	-0.37	-0.37
$\Delta_{ground(O,R)}$	-1.75	-1.71	-1.68	-1.66	-1.65	-1.65	-1.64	-1.64
A_{dif}	5.62	7.40	9.65	12.22	15.00	17.88	20.83	22.99
$A_{ground(S,R)}$	-	-	-	-	-	-	-	-
$A_{boundary,H}$	**5.62**	**7.40**	**9.65**	**12.22**	**15.00**	**17.88**	**20.83**	**22.99**

Table 5.3.19-8: Calculation of A boundary (Fav) – Reflection (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000
$\Delta_{dif(S,R)}$	7.22	8.76	10.80	13.24	15.93	18.77	21.69	24.65
$A_{ground,(S,O)}$	-0.43	-0.43	-0.43	-0.43	-0.43	-0.43	-0.43	-0.43
$A_{ground,(O,R)}$	-1.90	-1.90	-1.90	-1.90	-1.90	-1.90	-1.90	-1.90
$\Delta_{dif(S',R)}$	8.09	9.93	12.22	14.82	17.61	20.51	23.46	26.44
$\Delta_{dif(S,R')}$	8.08	9.91	12.20	14.80	17.59	20.48	23.43	26.41
$\Delta_{ground(S,O)}$	-0.39	-0.38	-0.37	-0.36	-0.36	-0.35	-0.35	-0.35
$\Delta_{ground(O,R)}$	-1.74	-1.69	-1.64	-1.61	-1.60	-1.59	-1.58	-1.58
A_{dif}	5.09	6.70	8.79	11.26	13.97	16.82	19.75	22.72
$A_{ground(S,R)}$	-	-	-	-	-	-	-	-
$A_{boundary,H}$	**5.09**	**6.70**	**8.79**	**11.26**	**13.97**	**16.82**	**19.75**	**22.72**

Table 5.3.19-9: Calculation of the A-weighted partial level for the reflected beam (Hom and Fav)– Reflection (Source: Umweltbundesamt [9])

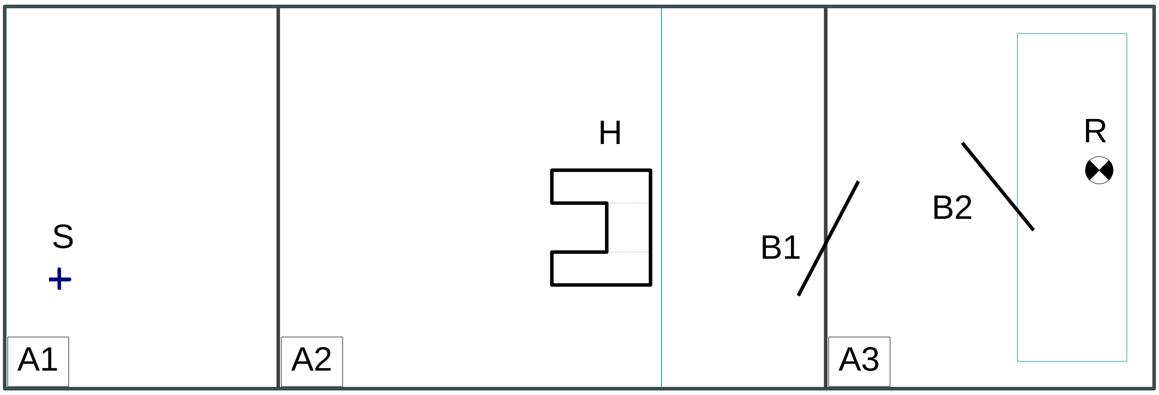
Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	
L_W in dB	93	93	93	93	93	93	93	93	
$dL_{abs,H}$	-0.46	-0.97	-1.55	-2.22	-3.01	-3.98	-5.23	-3.01	
$dL_{retrodif,H}$	2.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
$L_{W,H}$ in dB	**90.08**	**92.03**	**91.45**	**90.78**	**89.99**	**89.02**	**87.77**	**89.99**	
$\alpha_{atm,H}$	0.1	0.4	1.0	1.9	3.7	9.7	32.8	116.9	
$A_{atm,H}$ in dB	0.02	0.08	0.21	0.38	0.73	1.92	6.50	23.18	
A_{div} in dB	56.95	56.95	56.95	56.95	56.95	56.95	56.95	56.95	
$A_{boundary,H}$ in dB	5.62	7.40	9.65	12.22	15.00	17.88	20.83	22.99	
L_H in dB	27.49	27.60	24.64	21.23	17.32	12.27	3.49	-13.13	
$dL_{abs,F}$	-0.46	-0.97	-1.55	-2.22	-3.01	-3.98	-5.23	-3.01	
$dL_{retrodif,F}$	2.77	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
$L_{W,F}$ in dB	89.78	92.03	91.45	90.78	89.99	89.02	87.77	89.99	
$\alpha_{atm,F}$	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
$A_{atm,F}$ in dB	0.02	0.08	0.21	0.38	0.73	1.92	6.50	23.18	
A_{div} in dB	56.95	56.95	56.95	56.95	56.95	56.95	56.95	56.95	
$A_{boundary,F}$ in dB	5.09	6.70	8.79	11.26	13.97	16.82	19.75	22.72	
L_F in dB	27.71	28.30	25.50	22.19	18.34	13.33	4.57	-12.86	
L in dB	27.60	27.97	25.09	21.74	17.86	12.83	4.07	-13.00	
A-correction in dB	-26.2	-16.1	-8.6	-3.2	0.0	1.2	1.0	-1.1	**Total**
L_A in dB	**1.40**	**11.87**	**16.49**	**18.54**	**17.86**	**14.03**	**5.07**	**-14.10**	**23.47**

Table 5.3.19-10: Calculation of the A-weighted total level (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	Total
LA in dB direct sound	11.26	21.30	28.68	32.54	36.77	36.80	32.11	13.65	41.42
LA in dB reflection	1.40	11.87	16.49	18.54	17.86	14.03	5.07	-14.10	23.47
LA in dB	**11.69**	**21.77**	**28.93**	**32.71**	**36.83**	**36.83**	**32.12**	**13.66**	**41.49**

5.3.20 TC 19 - House and 2 walls on ground with varying heights and ground factors G

Figure 5.3.20-1: House H and 2 walls B1 and B2 on ground with varying heights and acoustic properties (S source, R point of immission, A1 area with G=0.9, A2 area with G=0.5, A3 area with G=0.2) (Source: Umweltbundesamt [9])



This test case checks the selection of the laterally diffractive edges and the calculation of the MGL's applicable to these paths.

The following two test cases relate to a specific issue: According to agreements made, only those buildings are included in the calculation of the lateral diffraction, which result in a positive detour with the direct beam S - R. The buildings are then included in the calculation of the lateral diffraction. In the case of a slight higher detour with straight beams (homogeneous), diffraction may not occur under favorable propagation conditions ($\Delta_{dif,F} = 0$), but it may occur under homogeneous conditions. In this case, lateral diffraction should only be considered in the calculation for homogeneous dispersion conditions, but not for favorable dispersion conditions.

Table 5.3.20-1: Coordinates of source S and point of immission R (Source: Umweltbundesamt [9])

Point	x (m)	y (m)	z (abs) (m)
S	10	10	1
R	200	30	14

Table 5.3.20-2: Coordinates of sound barriers (upper edge) (Source: Umweltbundesamt [9])

Barrier No.	x (m)	y (m)	z (m)
1	156.0	28.0	14.0
1	145.0	7.0	14.0
2	175.0	35.0	14.5
2	188.0	19.0	14.5

Table 5.3.20-3: Coordinates of the houses (Source: Umweltbundesamt [9])

Building No.	Corner No.	x (m)	y (m)	z (abs) (m)
1	1	100.0	24.0	12.0
1	2	118.0	24.0	12.0
1	3	118.0	30.0	12.0
1	4	100.0	30.0	12.0
2	5	110.0	15.0	7.0
2	6	118.0	15.0	7.0
2	7	118.0	24.0	7.0
2	8	110.0	24.0	7.0
3	9	100.0	9.0	12.0
3	10	118.0	9.0	12.0
3	11	118.0	15.0	12.0
3	12	100.0	15.0	12.0

Table 5.3.20-4: Height profiles for the direct and the two lateral ways for Hom (Source: Umweltbundesamt [9])

z-Profile S-O		z-Profile O-R		z-Profile right		z-Profile left	
u (m)	z (m)	u (m)	z (m)	u (m)	z (m)	u (m)	z (m)
0.00	0.00	171.66	9.34	0.00	0.00	0.00	0.00
100.55	0.00	175.97	10.00	110.03	0.00	93.44	0.00
100.55	7.00	191.05	10.00	135.03	3.85	93.44	12.00
108.60	7.00			176.56	10.00	109.23	12.00
108.60	0.00			179.68	10.00	109.23	0.00
110.61	0.00			195.96	10.00	111.26	0.00
145.34	5.31					166.88	8.46
						177.08	10.00
						192.38	10.00

Table 5.3.20-5: Determination of Gpath (Hom) (Source: Umweltbundesamt [9])

G-Profile S -> O				G-Profile O -> R			
from (m)	to (m)	length (m)	G	from (m)	to (m)	length (m)	G
0.00	40.22	40.22	0.9	0.00	19.39	19.39	0.2
40.22	100.55	60.33	0.5			Gpath	0.20
100.55	108.60	8.04	0				
108.60	140.77	32.18	0.5				
140.77	145.34	4.57	0.2				
		Gpath	0.57				

Table 5.3.20-6: G-profile on the lateral detours (Hom) (Source: Umweltbundesamt [9])

G-Profile lateral right				G-Profile lateral left			
from (m)	to (m)	length (m)	G	from (m)	to (m)	length (m)	G
0.00	40.01	40.01	0.9	0.00	40.46	40.46	0.9
40.01	135.03	95.02	0.5	40.46	93.44	52.98	0.5
135.03	140.22	5.19	0.5	93.44	109.23	15.79	0
140.22	179.67	39.45	0.2	109.23	141.60	32.37	0.5
179.67	195.96	16.28	0.2			Gpath	0.46
		Gpath	0.50				

Table 5.3.20-7: z-height profile along the propagation path (Source: Umweltbundesamt [9])

z-Profile S - R		
No.	u (m)	v (m)
1	0.00	0.00
2	100.55	0.00
3	100.55	7.00
4	108.60	7.00
5	108.60	0.00
6	110.61	0.00
7	145.34	5.31
8	145.34	14.00
9	145.34	5.31
10	171.65	9.34
11	171.66	14.50
12	171.66	9.34
13	175.97	10.00
14	191.05	10.00

Table 5.3.20-8: Mean ground levels MGL and average ground factors (Hom) (Source: Umweltbundesamt [9])

Parameters	S -> O1	On -> R	S->R ri	S->R le
a (MGL)	0.03	0.02	0.06	0.06
b (MGL)	-1.09	6.42	-2.92	-2.01
z1	2.09	4.76	3.92	3.00
z2	10.86	3.89	5.66	5.00
dp	145.65	19.38	196.38	192.81
Gpath	0.57	0.20	0.50	0.46
G'path	0.78		0.62	0.55

Table 5.3.20-9: Detour calculation due to sound barriers (Source: Umweltbundesamt [9])

Para-meters	S -> R		S '-> R		S -> R'		Lateral right		Lateral left	
	Hom	Fav	Hom	Fav	Hom	Fav	Hom	Fav	Hom	Fav
KA1	8	8	8	8	8	8	-	-	-	-
KA2	11	11	11	11	11	11	-	-	-	-
dir	191.49	191.62	191.70	191.82	191.27	191.40	191.49	191.49	191.49	191.49
dss	145.92	145.98	146.23	146.29	145.92	145.98	135.34	135.34	167.27	167.27
dsr	19.40	19.40	19.40	19.40	21.22	21.22	16.31	16.31	25.55	25.55
e	26.32	26.32	26.32	26.32	26.32	26.32	44.74	44.74	0.00	0.00
z	0.15	0.08	0.25	0.18	2.19	2.12	4.90	4.90	1.33	1.33

Table 5.3.20-10: Calculation of A boundary (Hom) (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000
$\Delta_{dif(S,R)}$	6.67	8.83	11.68	14.56	17.43	20.35	23.31	26.29
$A_{ground,(S,O)}$	-0.67	-0.67	-0.67	-0.67	-0.67	-0.67	-0.67	-0.67
$A_{ground,(O,R)}$	-2.02	-2.40	-2.40	-2.40	-2.40	-2.40	-2.40	-2.40
$\Delta_{dif(S',R)}$	7.61	10.35	13.58	16.64	19.61	22.57	25.55	28.55
$\Delta_{dif(S,R')}$	14.32	18.51	22.43	25.77	28.86	31.89	34.91	37.92
$\Delta_{ground(S,O)}$	-0.60	-0.56	-0.54	-0.53	-0.52	-0.52	-0.52	-0.52
$\Delta_{ground(O,R)}$	-0.90	-0.86	-0.77	-0.73	-0.71	-0.70	-0.70	-0.70
A_{dif}	5.17	7.41	10.38	13.30	16.20	19.13	22.09	23.78
$A_{ground(S,R)}$	-	-	-	-	-	-	-	-
$A_{boundary,H}$	**5.17**	**7.41**	**10.38**	**13.30**	**16.20**	**19.13**	**22.09**	**23.78**

Table 5.3.20-11: Calculation of A boundary (Fav) (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000
$\Delta_{dif(S,R)}$	5.89	7.40	9.69	12.24	14.94	17.76	20.66	23.62
$A_{ground,(S,O)}$	-0.67	-0.67	-0.67	-0.67	-0.67	-0.67	-0.67	-0.67
$A_{ground,(O,R)}$	-2.08	-2.40	-2.40	-2.40	-2.40	-2.40	-2.40	-2.40
$\Delta_{dif(S',R)}$	7.00	9.39	12.40	15.35	18.27	21.21	24.17	27.16
$\Delta_{dif(S,R')}$	14.20	18.38	22.29	25.63	28.73	31.75	34.77	37.78
$\Delta_{ground(S,O)}$	-0.59	-0.53	-0.49	-0.47	-0.46	-0.45	-0.45	-0.45
$\Delta_{ground(O,R)}$	-0.86	-0.75	-0.62	-0.57	-0.55	-0.53	-0.53	-0.53
A_{dif}	4.44	6.12	8.57	11.19	13.93	16.77	19.68	22.64
$A_{ground(S,R)}$	-	-	-	-	-	-	-	-
$A_{boundary,H}$	**4.44**	**6.12**	**8.57**	**11.19**	**13.93**	**16.77**	**19.68**	**22.64**

Table 5.3.20-12: Spectral intermediate and final results for the vertical propagation plane (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	
L_W in dB	93	93	93	93	93	93	93	93	
α_{atm}	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.02	0.08	0.20	0.37	0.70	1.85	6.28	22.38	
A_{div} in dB	56.64	56.64	56.64	56.64	56.64	56.64	56.64	56.64	
$A_{boundary,H}$ in dB	5.17	7.41	10.38	13.30	16.20	19.13	22.09	23.78	
$A_{boundary,F}$ in dB	4.44	6.12	8.57	11.19	13.93	16.77	19.68	22.64	**Total**
L_H in dB	31.16	28.87	25.78	22.69	19.46	15.38	7.99	-9.81	34.43
L_F in dB	31.89	30.16	27.59	24.79	21.73	17.74	10.40	-8.67	35.66
L in dB	31.54	29.56	26.78	23.87	20.74	16.72	9.36	-9.20	35.08
A-weighting dB	-26.2	-16.1	-8.6	-3.2	0.0	1.2	1.0	-1.1	
L_A^a in dB	**5.34**	**13.46**	**18.18**	**20.67**	**20.74**	**17.92**	**10.36**	**-10.30**	**26.01**

Table 5.3.20-13: Ground attenuation for lateral propagation (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000
lateral right								
w hom	0.00	0.00	0.00	0.02	0.13	0.70	3.46	15.82
Cf hom	204.75	223.53	212.65	88.09	10.70	1.43	0.29	0.06
A ground-right hom	**-1.13**	**-1.13**	**-0.97**	**-0.65**	**-1.13**	**-1.13**	**-1.13**	**-1.13**
w fav	0.00	0.00	0.00	0.01	0.08	0.40	2.07	9.97
Cf fav	201.41	215.78	228.09	136.20	24.26	2.53	0.48	0.10
A ground-right fav	**-1.13**	**-1.13**	**-1.13**	**-1.13**	**-1.13**	**-1.13**	**-1.13**	**-1.13**
lateral left								
w hom	0.00	0.00	0.00	0.02	0.10	0.51	2.61	12.30
Cf hom	198.93	214.98	219.72	113.73	17.06	1.95	0.38	0.08
A ground- left hom	**-1.35**	**-1.35**	**-1.35**	**1.32**	**-1.35**	**-1.35**	**-1.35**	**-1.35**
w fav	0.00	0.00	0.00	0.01	0.06	0.34	1.77	8.65
Cf fav	196.96	209.53	225.50	149.30	30.69	3.06	0.56	0.12
A ground- left Fav	**-1.35**	**-1.35**	**-1.35**	**-1.35**	**-1.35**	**-1.35**	**-1.35**	**-1.35**

Table 5.3.20-14: Calculation of the unweighted partial level for the right detour (Hom) (Source: Umweltbundesamt [9])

lateral right H									
Frequency (Hz)-->	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	
L_W in dB	93	93	93	93	93	93	93	93	
α-atm(10°,70%)	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.02	0.08	0.20	0.38	0.72	1.90	6.44	22.95	
A_{div} in dB	56.64	56.64	56.64	56.64	56.64	56.64	56.64	56.64	
$A_{ground,H}$ in dB	-1.13	-1.13	-0.97	-0.65	-1.13	-1.13	-1.13	-1.13	
$\Delta_{dif,H}$ in dB	18.69	22.74	26.20	29.33	32.37	35.39	38.40	41.41	
A_H in dB	74.23	78.33	82.07	85.71	88.61	92.80	100.35	119.88	**Total**
L_H in dB	**18.77**	**14.67**	**10.93**	**7.29**	**4.39**	**0.20**	**-7.35**	**-26.88**	**21.01**

Table 5.3.20-15: Calculation of the unweighted partia l level for the right detour (Fav) (Source: Umweltbundesamt [9])

Lateral right F									
Frequency (Hz)-->	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	
L_W in dB	93	93	93	93	93	93	93	93	
α-atm(10°,70%)	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.02	0.08	0.20	0.38	0.72	1.90	6.44	22.95	
A_{div} in dB	56.64	56.64	56.64	56.64	56.64	56.64	56.64	56.64	
$A_{ground,F}$ in dB	-1.13	-1.13	-1.13	-1.13	-1.13	-1.13	-1.13	-1.13	
$\Delta_{dif,F}$ in dB	18.69	22.74	26.20	29.33	32.37	35.39	38.40	41.41	
A_F in dB	74.23	78.33	81.92	85.23	88.61	92.80	100.35	119.88	**Total**
L_F in dB	**18.77**	**14.67**	**11.08**	**7.77**	**4.39**	**0.20**	**-7.35**	**-26.88**	**21.05**

Table 5.3.20-16: Calculation of the unweighted partial level for the left detour (Hom) (Source: Umweltbundesamt [9])

Lateral left H									
Frequency (Hz)-->	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	
L_W in dB	93	93	93	93	93	93	93	93	
α-atm(10°,70%)	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.02	0.08	0.20	0.37	0.71	1.86	6.32	22.54	
A_{div} in dB	56.64	56.64	56.64	56.64	56.64	56.64	56.64	56.64	
$A_{ground,H}$ in dB	-1.35	-1.35	-1.35	1.32	-1.35	-1.35	-1.35	-1.35	
$\Delta_{dif,H}$ in dB	11.08	13.52	16.24	19.09	22.02	24.99	27.98	30.98	
A_H in dB	66.40	68.90	71.73	77.43	78.01	82.14	89.59	108.80	**Total**
L_H in dB	**26.60**	**24.10**	**21.27**	**15.57**	**14.99**	**10.86**	**3.41**	**-15.80**	**29.69**

Table 5.3.20-17: Calculation of the unweighted partial level for the left detour (Fav) (Source: Umweltbundesamt [9])

Lateral left F									
Frequency (Hz)-->	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	
L_W in dB	93	93	93	93	93	93	93	93	
α-atm(10°,70%)	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.02	0.08	0.20	0.37	0.71	1.86	6.32	22.54	
A_{div} in dB	56.64	56.64	56.64	56.64	56.64	56.64	56.64	56.64	
$A_{ground,F}$ in dB	-1.35	-1.35	-1.35	-1.35	-1.35	-1.35	-1.35	-1.35	
$\Delta_{dif,F}$ in dB	11.08	13.52	16.24	19.09	22.02	24.99	27.98	30.98	
A_F in dB	66.40	68.90	71.73	74.75	78.01	82.14	89.59	108.80	**Total**
L_F in dB	**26.60**	**24.10**	**21.27**	**18.25**	**14.99**	**10.86**	**3.41**	**-15.80**	**29.83**

Table 5.3.20-18: Partial and total levels for the three propagation paths (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	
L_A in dB top	5.34	13.46	18.18	20.67	20.74	17.92	10.36	-10.30	
L_A in dB right	-7.43	-1.43	2.41	4.34	4.39	1.40	-6.35	-27.98	
L_A in dB left	0.40	8.00	12.67	13.91	14.99	12.06	4.41	-16.90	**Total**
L_A in dB	**6.72**	**14.66**	**19.34**	**21.58**	**21.84**	**19.00**	**11.42**	**-9.38**	**27.08**

5.3.21 TC 20 - Ground with varying heights and ground factors G

This base scenario is used for comparison with the following calculation TC 21 with the inserted house.

Figure 5.3.21-1: Ground of different heights and acoustic properties (S source, R point of immission, A1 area with G=0.9, A2 area with G=0.5, A3 area with G=0.2) (Source: Umweltbundesamt [9])

Table 5.3.21-1: Coordinates of source S and point of immission R (Source: Umweltbundesamt [9])

Point	x (m)	y (m)	z (abs) (m)
S	10	10	1
R	200	25	14

Table 5.3.21-2: Contour lines to describe the ground model (Source: Umweltbundesamt [9])

No.	x1 (m)	y1 (m)	z1 (m)	x2 (m)	y2 (m)	z2 (m)
1	185	-5	10	205	-5	10
2	205	-5	10	205	60	10
3	205	60	10	185	60	10
4	0	70	0	0	-10	0

Table 5.3.21-3: Rectangular areas with a given ground index G (Source: Umweltbundesamt [9])

G	x (m)		y (m)	
	min	max	min	max
0.9	0.0	50.0	-10.0	70.0
0.5	50.0	150.0	-10.0	70.0
0.2	150.0	210.0	-10.0	70.0

Table 5.3.21-4: z-height profile along the propagation path (Source: Umweltbundesamt [9])

z-Profile S - R		
No.	**u (m)**	**v (m)**
1	0.00	0.00
2	110.34	0.00
3	175.54	10.00
4	190.59	10.00

Table 5.3.21-5: Ground attenuation (relevant if no diffraction) (Source: Umweltbundesamt [9])

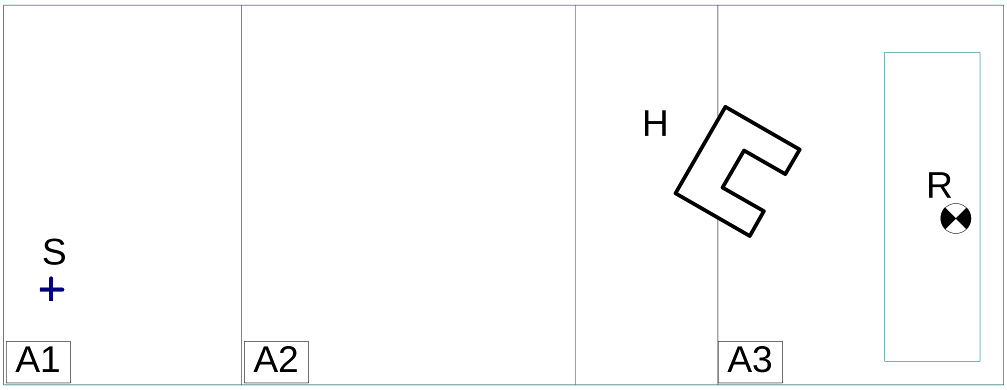
Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000
w (H)	1,6E-04	8,8E-04	4,9E-03	0.03	0.15	0.76	3.76	17.01
C_f (H)	199.65	218.28	203.92	80.61	9.46	1.31	0.27	0.06
$A_{ground,H}$	**-1.06**	**-1.06**	**-1.06**	**-1.06**	**-1.06**	**-1.06**	**-1.06**	**-1.06**
w (F)	0.00	0.00	0.00	0.01	0.08	0.42	2.16	10.35
C_f (F)	195.99	210.11	221.65	131.04	23.06	2.42	0.46	0.10
$A_{ground,F}$	**-1.06**	**-1.06**	**-1.06**	**-1.06**	**-1.06**	**-1.06**	**-1.06**	**-1.06**

Table 5.3.21-6: Spectral intermediate and final results for the vertical propagation plane (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	
L_W in dB	93	93	93	93	93	93	93	93	
α_{atm}	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.02	0.08	0.20	0.37	0.70	1.85	6.26	22.33	
A_{div} in dB	56.62	56.62	56.62	56.62	56.62	56.62	56.62	56.62	
$A_{boundary,H}$ in dB	-1.06	-1.06	-1.06	-1.06	-1.06	-1.06	-1.06	-1.06	
$A_{boundary,F}$ in dB	-1.06	-1.06	-1.06	-1.06	-1.06	-1.06	-1.06	-1.06	**Total**
L_H in dB	37.41	37.35	37.23	37.06	36.73	35.59	31.17	15.10	44.91
L_F in dB	37.41	37.35	37.23	37.06	36.73	35.59	31.17	15.10	44.91
L in dB	37.41	37.35	37.23	37.06	36.73	35.59	31.17	15.10	44.91
A-weighting dB	-26.2	-16.1	-8.6	-3.2	0.0	1.2	1.0	-1.1	
$L_A{}^a$ in dB	**11.21**	**21.25**	**28.63**	**33.86**	**36.73**	**36.79**	**32.17**	**14.00**	**41.61**

5.3.22 TC 21 - House on ground with varying heights and ground factors G

Figure 5.3.22-1: Scenario of TC 20 with inserted U-shaped house (Source: Umweltbundesamt [9])



The initial data of test case TC20 remains unchanged. Only the house is added.

The calculation again concerns the correct evaluation of the edges of the sound barrier according to the Rayleigh Criterion.

Table 5.3.22-1: Coordinates of the houses (Source: Umweltbundesamt [9])

Building No.	Corner No.	x (m)	y (m)	z (abs) (m)
1	1	167.2	39.5	11.5
1	2	151.6	48.5	11.5
1	3	141.1	30.3	11.5
1	4	156.7	21.3	11.5
1	5	159.7	26.5	11.5
1	6	151.0	31.5	11.5
1	7	155.5	39.3	11.5
1	8	164.2	34.3	11.5

Table 5.3.22-2: Height profiles for the direct and the two lateral ways for Hom (Source: Umweltbundesamt [9])

z-Profile S-O		z-Profile O-R		z-Profile right		z-Profile left	
u (m)	z (m)	u (m)	z (m)	u (m)	z (m)	u (m)	z (m)
0.00	0.00	146.75	11.50	0.00	0.00	0.00	0.00
110.34	0.00	147.26	11.50	110.33	0.00	114.00	0.00
146.75	5.58	147.26	5.66	147.10	5.64	146.72	4.86
		175.54	10.00	175.54	10.00	183.89	10.00
		190.59	10.00	190.59	10.00	200.57	10.00

Table 5.3.22-3: Determination of Gpath (Hom) (Source: Umweltbundesamt [9])

G-Profile S -> O				G-Profile O -> R			
from (m)	to (m)	length (m)	G	from (m)	to (m)	length (m)	G
0.00	40.12	40.12	0.9	0.00	0.51	0.51	0
40.13	140.43	100.31	0.5	0.51	43.84	43.33	0.20
140.44	146.75	6.32	0.2			Gpath	0.20
		Gpath	0.60				

Table 5.3.22-4: G-profile on the lateral detours (Hom) (Source: Umweltbundesamt [9])

G-Profile lateral right				G-Profile lateral left			
from (m)	to (m)	length (m)	G	from (m)	to (m)	length (m)	G
0.00	40.12	40.12	0.9	0.00	41.45	41.45	0.9
40.12	140.41	100.30	0.5	41.45	145.09	103.64	0.5
140.41	147.09	6.68	0.2	145.09	146.72	1.63	0.2
147.09	190.59	43.49	0.2	146.72	200.56	53.85	0.2
		Gpath	0.505			Gpath	0.50

Table 5.3.22-5: z-height profile along the propagation path (Source: Umweltbundesamt [9])

z-Profile S - R		
No.	u (m)	v (m)
1	0.00	0.00
2	110.34	0.00
3	146.75	5.58
4	146.75	11.50
5	147.26	11.50
6	147.26	5.66
7	175.54	10.00
8	190.59	10.00

Table 5.3.22-6: Mean ground levels MGL and average ground factors (Hom) (Source: Umweltbundesamt [9])

Parameters	S -> R	S -> O1	On -> R
a (MGL)	-	0.02	0.10
b (MGL)	-	-1.04	-8.64
z1	-	2.04	5.10
z2	-	9.07	3.12
dp	-	146.96	43.87
Gpath	-	0.60	0.20
G'path	-	0.77	

Table 5.3.22-7: Mean ground levels MGL and average ground factors (Fav) (Source: Umweltbundesamt [9])

Parameters	S -> R	S -> O1	On -> R
a (MGL)	0.06	0.02	0.11
b (MGL)	-2.84	-1.10	-10.12
z1	3.84	2.10	5.28
z2	6.12	8.93	3.00
dp	191.02	147.48	43.34
Gpath	0.50	0.59	0.20
G'path	0.65	0.76	

Table 5.3.22-8: Coordinates of the mirror points (Hom) (Source: Umweltbundesamt [9])

Mirror points	u	v
S' (S -> R)	-	-
R' (S -> R)	-	-
S' (S -> O)	0.10	-3.08
R' (O -> R)	191.23	7.79

Mirror points	u	v
S' (S -> R)	0.43	-6.66
R' (S -> R)	191.28	1.79
S' (S -> O)	0.10	-3.21
R' (O -> R)	191.25	8.04

Table 5.3.22-9: Coordinates of the mirror points (Fav) (Source: Umweltbundesamt [9])

Mirror points	u	v
S' (S -> R)	0.43	-6.66
R' (S -> R)	191.28	1.79
S' (S -> O)	0.10	-3.21
R' (O -> R)	191.25	8.04

Table 5.3.22-10: Detour calculation for sound barriers (Source: Umweltbundesamt [9])

Parameters	S -> R		S '-> R		S -> R'		Lateral right		Lateral left	
	Hom	Fav	Hom	Fav	Hom	Fav	Hom	Fav	Hom	Fav
KA1	4	5	4	5	4	5	-		-	
KA2	4	5	4	5	4	5	-		-	
dir	191.03	191.16	191.26	191.39	191.35	191.51	191.03		191.03	
dss	147.13	147.69	147.38	147.95	147.13	147.69	147.44		147.05	
dsr	43.91	43.40	43.91	43.40	44.63	44.13	43.60		53.94	
e	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	
z	0.004	-0.063	0.030	-0.035	0.409	0.313	0.00087		9.954	

Table 5.3.22-11: Ground attenuation (relevant if no diffraction) (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000
w (H)	-	-	-	-	-	-	-	-
C_f (H)	-	-	-	-	-	-	-	-
$A_{ground,H}$	-	-	-	-	-	-	-	-
w (F)	0.00	0.00	-	0.01	0.08	0.42	2.15	10.33
C_f (F)	195.98	210.08	-	131.26	23.14	2.43	0.46	0.10
$A_{ground,F}$	**-1.06**	**-1.06**	-	**-1.06**	**-1.06**	**-1.06**	**-1.06**	**-1.06**

Table 5.3.22-12: Calculation of A boundary (Hom) (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000
$\Delta_{dif(S,R)}$	4.81	4.85	4.92	5.06	5.34	5.84	6.69	8.02
$A_{ground,(S,O)}$	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70	-0.70
$A_{ground,(O,R)}$	-0.47	-1.57	-2.41	-2.41	-2.41	-2.41	-2.41	-2.41
$\Delta_{dif(S',R)}$	5.08	5.37	5.89	6.78	8.15	10.03	12.34	14.95
$\Delta_{dif(S,R')}$	7.81	9.55	11.77	14.33	17.09	19.97	22.92	25.89
$\Delta_{ground(S,O)}$	-0.68	-0.66	-0.63	-0.58	-0.51	-0.44	-0.37	-0.32
$\Delta_{ground(O,R)}$	-0.33	-0.95	-1.18	-0.91	-0.69	-0.53	-0.42	-0.35
A_{dif}	3.80	3.24	3.11	3.58	4.13	4.87	5.90	7.35
$A_{ground(S,R)}$	-	-	-	-	-	-	-	-
$A_{boundary,H}$	**3.80**	**3.24**	**3.11**	**3.58**	**4.13**	**4.87**	**5.90**	**7.35**

Table 5.3.22-13: Calculation of A boundary (Fav) (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000
$\Delta_{dif(S,R)}$	0.00	0.00	0.64	0.00	0.00	0.00	0.00	0.00
$A_{ground,(S,O)}$	-	-	-0.71	-	-	-	-	-
$A_{ground,(O,R)}$	-	-	-2.40	-	-	-	-	-
$\Delta_{dif(S',R)}$	-	-	2.94	-	-	-	-	-
$\Delta_{dif(S,R')}$	-	-	10.87	-	-	-	-	-
$\Delta_{ground(S,O)}$	-	-	-0.55	-	-	-	-	-
$\Delta_{ground(O,R)}$	-	-	-0.81	-	-	-	-	-
A_{dif}	-	-	-0.72	-	-	-	-	-
$A_{ground(S,R)}$	-1.06	-1.06	-	-1.06	-1.06	-1.06	-1.06	-1.06
$A_{boundary,H}$	**-1.06**	**-1.06**	**-0.72**	**-1.06**	**-1.06**	**-1.06**	**-1.06**	**-1.06**

Table 5.3.22-14: Spectral intermediate and final results for the vertical propagation plane (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	
L_W in dB	93	93	93	93	93	93	93	93	
α_{atm}	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.02	0.08	0.20	0.37	0.70	1.85	6.26	22.33	
A_{div} in dB	56.62	56.62	56.62	56.62	56.62	56.62	56.62	56.62	
$A_{boundary,H}$ in dB	3.80	3.24	3.11	3.58	4.13	4.87	5.90	7.35	
$A_{boundary,F}$ in dB	-1.06	-1.06	-0.72	-1.06	-1.06	-1.06	-1.06	-1.06	**Total**
L_H in dB	32.56	33.06	33.07	32.43	31.54	29.66	24.22	6.70	40.10
L_F in dB	37.41	37.36	36.90	37.07	36.74	35.59	31.18	15.11	44.86
L in dB	35.63	35.72	35.39	35.34	34.88	33.57	28.96	12.68	43.10
A-weighting dB	-26.2	-16.1	-8.6	-3.2	0.0	1.2	1.0	-1.1	
$L_A{}^a$ in dB	**9.43**	**19.62**	**26.79**	**32.14**	**34.88**	**34.77**	**29.96**	**11.58**	**39.68**

Table 5.3.22-15: Ground attenuation for lateral propagation (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000
lateral right								
w hom	0.00	0.00	0.00	0.03	0.15	0.76	3.76	17.00
Cf hom	199.64	218.28	203.93	80.63	9.47	1.31	0.27	0.06
A ground-right hom	**-1.06**	**-1.06**	**-1.06**	**-1.06**	**-1.06**	**-1.06**	**-1.06**	**-1.06**
w fav								
Cf fav								
A ground-right fav								
lateral left								
w hom	0.00	0.00	0.00	0.02	0.13	0.70	3.48	15.89
Cf hom	209.75	229.14	216.34	87.81	10.49	1.42	0.29	0.06
A ground- left hom	**-1.12**	**-1.12**	**-1.02**	**-0.79**	**-1.12**	**-1.12**	**-1.12**	**-1.12**
w fav								
Cf fav								
A ground- left Fav								

Table 5.3.22-16: Calculation of the unweighted partial level for the right detour (Hom) (Source: Umweltbundesamt [9])

Lateral right H									
Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	
L_W in dB	93	93	93	93	93	93	93	93	
α-atm(10°,70%)	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.02	0.08	0.20	0.37	0.70	1.85	6.26	22.33	
A_{div} in dB	56.62	56.62	56.62	56.62	56.62	56.62	56.62	56.62	
$A_{ground,H}$ in dB	-1.06	-1.06	-1.06	-1.06	-1.06	-1.06	-1.06	-1.06	
$\Delta_{dif,H}$ in dB	4.78	4.79	4.81	4.84	4.92	5.06	5.33	5.82	
A_H in dB	60.37	60.44	60.57	60.78	61.18	62.47	67.15	83.71	**Total**
L_H in dB	**32.63**	**32.56**	**32.43**	**32.22**	**31.82**	**30.53**	**25.85**	**9.29**	**40.04**

Table 5.3.22-17: Calculation of the unweighted partial level for the left detour (Hom) (Source: Umweltbundesamt [9])

Lateral left H									
Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	
L_W in dB	93	93	93	93	93	93	93	93	
α-atm(10°,70%)	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.02	0.08	0.21	0.39	0.74	1.94	6.59	23.49	
A_{div} in dB	56.62	56.62	56.62	56.62	56.62	56.62	56.62	56.62	
$A_{ground,H}$ in dB	-1.12	-1.12	-1.02	-0.79	-1.12	-1.12	-1.12	-1.12	
$\Delta_{dif,H}$ in dB	18.85	21.74	24.71	27.70	30.70	33.70	36.71	39.72	
A_H in dB	74.38	77.32	80.52	83.92	86.93	91.14	98.79	118.71	**Total**
L_H in dB	**18.62**	**15.68**	**12.48**	**9.08**	**6.07**	**1.86**	**-5.79**	**-25.71**	**21.51**

Table 5.3.22-18: Partial and total levels for the three propagation paths (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	
L_A in dB top	9.43	19.62	26.79	32.14	34.88	34.77	29.96	11.58	
L_A in dB right	3.42	13.45	20.82	26.01	28.81	28.72	23.84	5.18	
L_A in dB left	-10.59	-3.44	0.87	2.87	3.06	0.05	-7.81	-29.82	**Total**
L_A in dB	**10.44**	**20.58**	**27.78**	**33.09**	**35.84**	**35.73**	**30.91**	**12.48**	**40.64**

5.3.23 TC 22 - House with rear facade point on ground with varying heights and ground factors G

The core of the test case is the calculation of the diffraction in EV with the immission site close to the facade and the rear lateral diffraction in EL in the last beam section.

Figure 5.3.23-1: Scenario like TC 20 with inserted U-shaped house with rear facade point (Source: Umweltbundesamt [9])

This test case concerns a special case of the calculation of immission points on the facade facing away from the source, which frequently occurs when buildings are the sound barrier.

Table 5.3.23-1: Coordinates of the houses (Source: Umweltbundesamt [9])

Building No.	Corner No.	x (m)	y (m)	z (abs) (m)
1	1	197.0	36.0	20.0
1	2	179.0	36.0	20.0
1	3	179.0	15.0	20.0
1	4	197.0	15.0	20.0
1	5	197.0	21.0	20.0
1	6	187.0	21.0	20.0
1	7	187.0	30.0	20.0
1	8	197.0	30.0	20.0

Table 5.3.23-2: Height profiles for the direct and the two lateral ways for Hom (Source: Umweltbundesamt [9])

z-Profile S-O		z-Profile O-R		z-Profile right		z-Profile left	
u (m)	z (m)	u (m)	z (m)	u (m)	z (m)	u (m)	z (m)
0.00	0.00	177.64	10.00	0.00	0.00	0.00	0.00
110.39	0.00	177.68	10.00	110.04	0.00	111.29	0.00
169.60	9.08			175.06	10.00	170.99	9.08
				187.07	10.00	176.99	10.00
				193.08	10.00	188.99	10.00
				203.80	10.00	195.00	10.00
						206.14	10.00

Table 5.3.23-3: Determination of Gpath (Hom) (Source: Umweltbundesamt [9])

G-Profile S -> O				G-Profile O -> R			
from (m)	to (m)	length (m)	G	from (m)	to (m)	length (m)	G
0.00	40.14	40.14	0.9	0.00	0.05	0.05	0.2
40.14	140.50	100.36	0.5			Gpath	0.20
140.50	169.61	29.10	0.2				
		Gpath	0.54				

Table 5.3.23-4: G-profile on the lateral detours (Hom) (Source: Umweltbundesamt [9])

G-Profile lateral right				G-Profile lateral left			
from (m)	to (m)	length (m)	G	from (m)	to (m)	length (m)	G
0.00	40.01	40.01	0.9	0.00	40.47	40.47	0.9
40.01	140.05	100.03	0.5	40.47	141.64	101.17	0.5
140.05	187.07	47.02	0.2	141.64	170.98	29.34	0.2
187.07	193.07	6.01	0.2	170.98	188.99	18.00	0.2
193.07	203.80	10.73	0.20	188.99	195.00	6.01	0.20
		Gpath	0.48	195.00	206.13	11.14	0.20
						Gpath	0.48

Table 5.3.23-5: z-height profile along the propagation path (Source: Umweltbundesamt [9])

z-Profile S - R		
No.	u (m)	v (m)
1	0.00	0.00
2	110.39	0.00
3	169.60	9.08
4	169.61	20.00
5	177.63	20.00
6	177.64	10.00
7	177.68	10.00

Table 5.3.23-6: Mean ground levels MGL and average ground factors (Hom) (Source: Umweltbundesamt [9])

Parameters	S -> O1	On -> R	S->R ri	S->R le
a (MGL)	0.04	0.00	0.06	0.06
b (MGL)	-2.06	10.00	-3.05	-3.05
z1	3.06	10.00	4.04	4.04
z2	14.75	4.00	4.93	4.93
dp	170.26	0.05	204.22	206.55
Gpath	0.54	0.20	0.48	0.48
G'path	0.79		0.58	0.58

Table 5.3.23-7: Coordinates of the mirror points (Hom)

Mirror points	u	v
S' (S -> O)	0.26	-5.11
R' (O -> R)	177.68	6.00

Table 5.3.23-8: Detour calculation for sound barriers (Source: Umweltbundesamt [9])

Para-meters	S -> R		S '-> R		S -> R'		Lateral right		Lateral left	
	Hom	Fav	Hom	Fav	Hom	Fav	Hom	Fav	Hom	Fav
KA1	4	4	4	4	4	4	-	-	-	-
KA2	5	5	5	5	5	5	-	-	-	-
dir	178.16	178.28	178.45	178.56	177.75	177.87	178.16	178.16	178.16	178.16
dss	170.67	170.77	171.19	171.30	170.67	170.77	187.57	187.57	171.44	171.44
dsr	6.00	6.00	6.00	6.00	14.00	14.00	10.75	10.75	11.16	11.16
e	8.03	8.03	8.03	8.03	8.03	8.03	6.01	6.01	24.06	24.06
z	6.54	6.52	6.78	6.76	14.94	14.93	26.17	26.17	28.51	28.51

Table 5.3.23-9: Calculation of A boundary (Hom) (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000
$\Delta_{dif(S,R)}$	17.34	20.76	25.01	29.48	33.28	36.55	39.63	42.66
$A_{ground,(S,O)}$	-0.64	-0.64	-0.64	-0.64	-0.64	-0.64	-0.64	-0.64
$A_{ground,(O,R)}$	-2.40	-2.40	-2.40	-2.40	-2.40	-2.40	-2.40	-2.40
$\Delta_{dif(S',R)}$	17.49	20.91	25.17	29.64	33.43	36.70	39.78	42.81
$\Delta_{dif(S,R')}$	20.79	24.29	28.58	33.06	36.87	40.14	43.22	46.25
$\Delta_{ground(S,O)}$	-0.63	-0.63	-0.63	-0.63	-0.63	-0.63	-0.63	-0.63
$\Delta_{ground(O,R)}$	-1.68	-1.67	-1.66	-1.66	-1.66	-1.66	-1.66	-1.66
A_{dif}	15.03	18.46	22.71	22.71	22.71	22.71	22.71	22.71
$A_{ground(S,R)}$	-	-	-	-	-	-	-	-
$A_{boundary,H}$	**15.03**	**18.46**	**22.71**	**22.71**	**22.71**	**22.71**	**22.71**	**22.71**

Table 5.3.23-10: Calculation of A boundary (Fav) (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000
$\Delta_{dif(S,R)}$	17.33	20.75	25.00	29.47	33.27	36.54	39.62	42.65
$A_{ground,(S,O)}$	-0.64	-0.64	-0.64	-0.64	-0.64	-0.64	-0.64	-0.64
$A_{ground,(O,R)}$	-2.40	-2.40	-2.40	-2.40	-2.40	-2.40	-2.40	-2.40
$\Delta_{dif(S',R)}$	17.48	20.90	25.16	29.63	33.43	36.70	39.78	42.80
$\Delta_{dif(S,R')}$	20.79	24.28	28.58	33.06	36.86	40.13	43.21	46.24
$\Delta_{ground(S,O)}$	-0.63	-0.63	-0.63	-0.63	-0.63	-0.63	-0.63	-0.63
$\Delta_{ground(O,R)}$	-1.68	-1.67	-1.66	-1.66	-1.66	-1.66	-1.66	-1.66
A_{dif}	15.02	18.45	22.71	22.71	22.71	22.71	22.71	22.71
$A_{ground(S,R)}$	-	-	-	-	-	-	-	-
$A_{boundary,H}$	**15.02**	**18.45**	**22.71**	**22.71**	**22.71**	**22.71**	**22.71**	**22.71**

Table 5.3.23-11: Spectral intermediate and final results for the vertical propagation plane (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	
L_W in dB	93	93	93	93	93	93	93	93	
α_{atm}	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.02	0.07	0.19	0.34	0.65	1.72	5.84	20.82	
A_{div} in dB	56.02	56.02	56.02	56.02	56.02	56.02	56.02	56.02	
$A_{boundary,H}$ in dB	15.03	18.46	22.71	22.71	22.71	22.71	22.71	22.71	
$A_{boundary,F}$ in dB	15.02	18.45	22.71	22.71	22.71	22.71	22.71	22.71	**Total**
L_H in dB	21.93	18.45	14.09	13.93	13.62	12.55	8.43	-6.55	25.11
L_F in dB	21.94	18.46	14.09	13.93	13.62	12.55	8.43	-6.55	25.12
L in dB	21.94	18.46	14.09	13.93	13.62	12.55	8.43	-6.55	25.12
A-weighting dB	-26.2	-16.1	-8.6	-3.2	0.0	1.2	1.0	-1.1	
$L_A{}^a$ in dB	**-4.26**	**2.36**	**5.49**	**10.73**	**13.62**	**13.75**	**9.43**	**-7.65**	**18.64**

Table 5.3.23-12: Ground attenuation for lateral propagation (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000
lateral right								
w hom	0.00	0.00	0.00	0.02	0.11	0.60	3.00	13.93
Cf hom	212.03	230.71	226.18	101.93	13.28	1.67	0.33	0.07
A ground-right hom	**-1.25**	**-1.25**	**-1.03**	**0.77**	**-1.25**	**-1.25**	**-1.25**	**-1.25**
w fav	0.00	0.00	0.00	0.01	0.07	0.38	1.96	9.49
Cf fav	209.34	224.10	237.46	143.50	25.94	2.69	0.51	0.11
A ground-right fav	**-1.25**	**-1.17**	**-1.25**	**-1.25**	**-1.25**	**-1.25**	**-1.25**	**-1.25**
lateral left								
w hom	0.00	0.00	0.00	0.02	0.11	0.59	2.96	13.76
Cf hom	214.41	233.28	228.92	103.46	13.51	1.70	0.34	0.07
A ground- left hom	**-1.26**	**-1.26**	**-1.05**	**0.86**	**-1.26**	**-1.26**	**-1.26**	**-1.26**
w fav	0.00	0.00	0.00	0.01	0.07	0.38	1.96	9.49
Cf fav	211.78	226.80	240.03	144.13	25.83	2.69	0.51	0.11
A ground- left Fav	**-1.26**	**-1.18**	**-1.26**	**-1.26**	**-1.26**	**-1.26**	**-1.26**	**-1.26**

Table 5.3.23-13: Calculation of the unweighted partial level for the right detour (Hom) (Source: Umweltbundesamt [9])

Lateral right H									
Frequency (Hz)-->	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	
L_W in dB	93	93	93	93	93	93	93	93	
α-atm(10°,70%)	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.02	0.08	0.21	0.39	0.75	1.97	6.70	23.88	
A_{div} in dB	56.02	56.02	56.02	56.02	56.02	56.02	56.02	56.02	
$A_{ground,H}$ in dB	-1.25	-1.25	-1.03	0.77	-1.25	-1.25	-1.25	-1.25	
$\Delta_{dif,H}$ in dB	23.08	26.38	30.38	34.93	39.06	42.50	45.63	48.67	
A_H in dB	77.88	81.24	85.57	92.12	94.57	99.24	107.10	127.33	**Total**
L_H in dB	**15.12**	**11.76**	**7.43**	**0.88**	**-1.57**	**-6.24**	**-14.10**	**-34.33**	**17.42**

Table 5.3.23-14: Calculation of the unweighted partial level for the right detour (Fav) (Source: Umweltbundesamt [9])

Lateral right F									
Frequency (Hz)-->	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	
L_W in dB	93	93	93	93	93	93	93	93	
α-atm(10°,70%)	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.02	0.08	0.21	0.39	0.75	1.97	6.70	23.88	
A_{div} in dB	56.02	56.02	56.02	56.02	56.02	56.02	56.02	56.02	
$A_{ground,F}$ in dB	-1.25	-1.17	-1.25	-1.25	-1.25	-1.25	-1.25	-1.25	
$\Delta_{dif,F}$ in dB	23.08	26.38	30.38	34.93	39.06	42.50	45.63	48.67	
A_F in dB	77.88	81.31	85.36	90.10	94.57	99.24	107.10	127.33	**Total**
L_F in dB	**15.12**	**11.69**	**7.64**	**2.90**	**-1.57**	**-6.24**	**-14.10**	**-34.33**	**17.48**

Table 5.3.23-15: Calculation of the unweighted partial level for the left detour (Hom) (Source: Umweltbundesamt [9])

Lateral left H									
Frequency (Hz)-->	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	
L_W in dB	93	93	93	93	93	93	93	93	
α-atm(10°,70%)	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.03	0.08	0.22	0.40	0.76	2.00	6.77	24.16	
A_{div} in dB	56.02	56.02	56.02	56.02	56.02	56.02	56.02	56.02	
$A_{ground,H}$ in dB	-1.26	-1.26	-1.05	0.86	-1.26	-1.26	-1.26	-1.26	
$\Delta_{dif,H}$ in dB	24.81	29.30	33.41	36.85	39.98	43.03	46.04	49.06	
A_H in dB	79.60	84.14	88.60	94.13	95.50	99.78	107.58	127.97	**Total**
L_H in dB	**13.40**	**8.86**	**4.40**	**-1.13**	**-2.50**	**-6.78**	**-14.58**	**-34.97**	**15.30**

Table 5.3.23-16: Calculation of the unweighted partial level for the left detour (Fav) (Source: Umweltbundesamt [9])

Lateral left F									
Frequency (Hz)-->	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	
L_W in dB	93	93	93	93	93	93	93	93	
α-atm(10°,70%)	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.03	0.08	0.22	0.40	0.76	2.00	6.77	24.16	
A_{div} in dB	56.02	56.02	56.02	56.02	56.02	56.02	56.02	56.02	
$A_{ground,F}$ in dB	-1.26	-1.18	-1.26	-1.26	-1.26	-1.26	-1.26	-1.26	
$\Delta_{dif,F}$ in dB	24.81	29.30	33.41	36.85	39.98	43.03	46.04	49.06	
A_F in dB	79.60	84.22	88.39	92.01	95.50	99.78	107.58	127.97	**Total**
L_F in dB	**13.40**	**8.78**	**4.61**	**0.99**	**-2.50**	**-6.78**	**-14.58**	**-34.97**	**15.37**

Table 5.3.23-17: Table 252- Calculation of the A-weighted total level (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	
L_H(vert) in dB	21.93	18.45	14.09	13.93	13.62	12.55	8.43	-6.55	
L_H (right) in dB	15.12	11.76	7.43	0.88	-1.57	-6.24	-14.10	-34.33	
L_H (left) in dB	13.40	8.86	4.40	-1.13	-2.50	-6.78	-14.58	-34.97	
L_H(tot) in dB	23.23	19.67	15.31	14.27	13.85	12.66	8.48	-6.54	
L_H(vert) in dB	21.94	18.46	14.09	13.93	13.62	12.55	8.43	-6.55	
L_F(right) in dB	15.12	11.69	7.64	2.90	-1.57	-6.24	-14.10	-34.33	
L_F(left) in dB	13.40	8.78	4.61	0.99	-2.50	-6.78	-14.58	-34.97	
L_F(tot) in dB	23.24	19.66	15.36	14.46	13.85	12.66	8.48	-6.54	**Total**
L in dB	23.24	19.66	15.33	14.37	13.85	12.66	8.48	-6.54	**26.18**
A-correction in dB	-26.2	-16.1	-8.6	-3.2	0	1.2	1	-1.1	
L_A in dB	**-2.96**	**3.56**	**6.73**	**11.17**	**13.85**	**13.86**	**9.48**	**-7.64**	**18.93**

5.3.24 TC 23 - Earth wall or elevated ground as sound barrier

Figure 5.3.24-1: Scenario with wall and two buildings H1 and H2 - point of immission before H1 (Source: Umweltbundesamt [9])

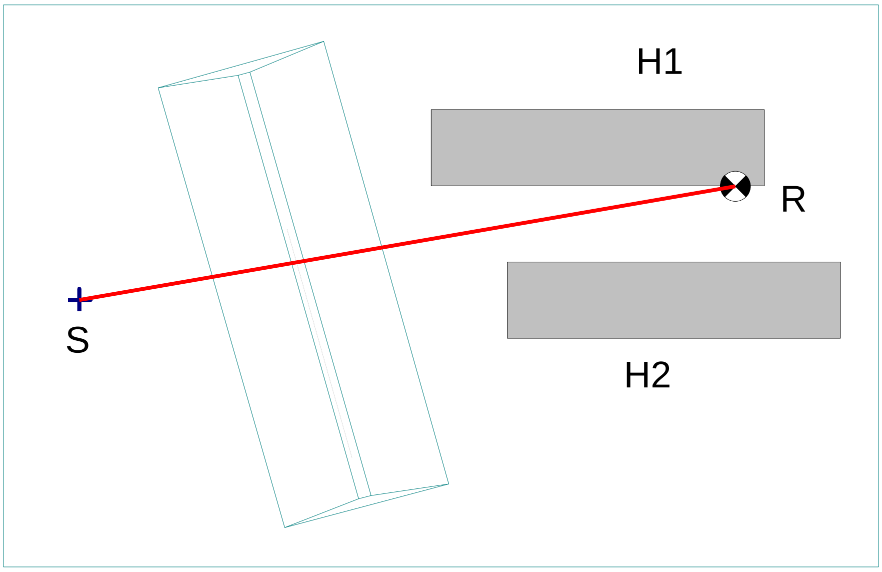
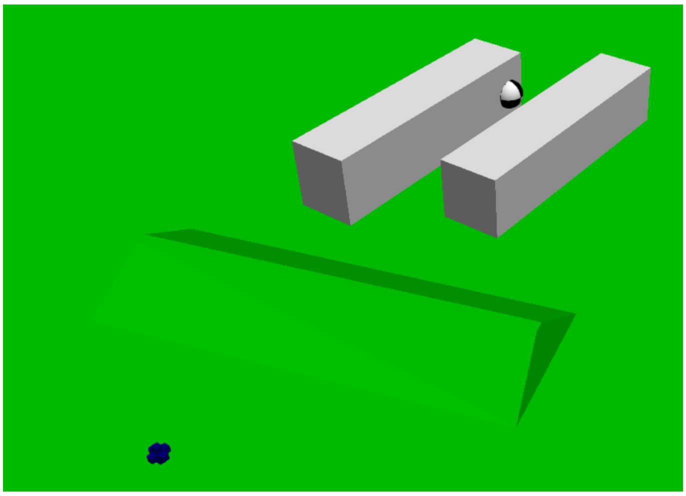


Figure 5.3.24-2: Scenario with wall and two buildings H1 and H2 - point of immission before H1 H1 H1 (Source: Umweltbundesamt [9])



This scenario is of an earth wall as a simple sound barrier.

Table 5.3.24-1: Coordinates of source S and point of immission R (Source: Umweltbundesamt [9])

Point	x (m)	y (m)	z (abs) (m)
S	38	14	1
R	107	25.95	4

Table 5.3.24-2: Contour lines to describe the ground model (Source: Umweltbundesamt [9])

No.	x1 (m)	y1 (m)	z1 (m)	x2 (m)	y2 (m)	z2 (m)
1	56	38	5	69	-6	5
2	67	-7	5	69	-6	5
3	69	-6	5	77	-5	0
4	46	36	0	60	-10	0

Table 5.3.24-3: Coordinates of the houses (Source: Umweltbundesamt [9])

Building No.	Corner No.	x (m)	y (m)	z (abs) (m)
1	1	75.0	34.0	9.0
1	2	110.0	34.0	9.0
1	3	110.0	26.0	9.0
1	4	75.0	26.0	9.0
2	5	83.0	18.0	8.0
2	6	118.0	18.0	8.0
2	7	118.0	10.0	8.0
2	8	83.0	10.0	8.0

Table 5.3.24-4: z-height profile along the propagation path (Source: Umweltbundesamt [9])

z-Profile S - R		
No.	u (m)	v (m)
1	0.00	0.00
2	14.21	0.00
3	22.64	5.00
4	23.98	5.00
5	32.30	0.00
6	70.03	0.00

Table 5.3.24-5: Height profiles for the blocked direct sound path for Hom (Source: Umweltbundesamt [9])

z-Profile S-O		z-Profile O-R	
u (m)	z (m)	u (m)	z (m)
0.00	0.00	23.98	5.00
14.21	0.00	32.30	0.00
22.64	5.00	70.03	0.00

Table 5.3.24-6: Height profiles for the blocked direct sound path for Fav (Source: Umweltbundesamt [9])

z-Profile S-O		z-Profile O-R	
u (m)	z (m)	u (m)	z (m)
0.00	0.00	22.64	5.00
14.21	0.00	23.98	5.00
22.64	5.00	32.30	0.00
		70.03	0.00

Table 5.3.24-7: Determination of Gpath (Hom) (Source: Umweltbundesamt [9])

G-Profile S -> O				G-Profile O -> R			
from (m)	to (m)	length (m)	G	from (m)	to (m)	length (m)	G
0.00	14.21	14.21	0	0.00	8.33	8.33	1
14.21	22.64	8.43	1	8.33	46.05	37.72	0.00
		Gpath	0.37			Gpath	0.18

Table 5.3.24-8: Determination of Gpath (Fav) (Source: Umweltbundesamt [9])

G-Profile S -> O				G-Profile O -> R			
from (m)	to (m)	length (m)	G	from (m)	to (m)	length (m)	G
0.00	14.21	14.21	0	0.00	9.67	9.67	1
14.21	22.64	8.43	1	9.67	47.39	37.72	0
		Gpath	0.37			Gpath	0.20

Table 5.3.24-9: Mean ground levels MGL and average ground factors (Hom) (Source: Umweltbundesamt [9])

Parameters	S -> O1	On -> R
a (MGL)	0.19	-0.05
b (MGL)	-1.17	2.89
z1	2.13	3.35
z2	1.94	4.73
dp	22.99	46.04
Gpath	0.37	0.18
G'path	0.07	

Table 5.3.24-10: Mean ground levels MGL and average ground factors (Fav) (Source: Umweltbundesamt [9])

Parameters	S -> O1	On -> R
a (MGL)	0.19	-0.06
b (MGL)	-1.17	3.51
z1	2.13	2.91
z2	1.94	4.91
dp	22.99	47.36
Gpath	0.37	0.20
G'path	0.07	

Table 5.3.24-11: Coordinates of the mirror points (Hom) (Source: Umweltbundesamt [9])

Mirror points	u	v
S' (S -> O)	0.78	-3.19
R' (O -> R)	69.54	-5.46

Table 5.3.24-12: Coordinates of the mirror points (Fav) (Source: Umweltbundesamt [9])

Mirror points	u	v
S' (S -> O)	0.78	-3.19
R' (O -> R)	69.41	-5.80

Table 5.3.24-13: Detour calculation for sound barriers (Source: Umweltbundesamt [9])

Para-meters	S -> R		S '-> R		S -> R'		Lateral right		Lateral left	
	Hom	Fav	Hom	Fav	Hom	Fav	Hom	Fav	Hom	Fav
KA1	3	3	3	3	3	3				
KA2	4	3	4	3	4	3				
dir	70.09	70.11	69.62	69.64	69.84	69.75				
dss	22.99	22.99	23.35	23.35	22.99	22.99				
dsr	46.06	47.40	46.06	47.40	46.75	48.00				
e	1.34	0.00	1.34	0.00	1.34	0.00				
z	0.30	0.29	1.12	1.11	1.24	1.24				

Table 5.3.24-14: Calculation of A boundary (Hom) (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000
$\Delta_{dif(S,R)}$	7.17	8.69	10.78	13.46	16.98	21.34	25.53	29.05
$A_{ground,(S,O)}$	-1.02	-0.08	-0.73	-2.79	-2.79	-2.79	-2.79	-2.79
$A_{ground,(O,R)}$	-0.28	-1.00	-2.46	-2.46	-2.46	-2.46	-2.46	-2.46
$\Delta_{dif(S',R)}$	10.54	12.93	15.67	18.78	22.56	27.04	31.28	34.81
$\Delta_{dif(S,R')}$	10.86	13.28	16.05	19.18	22.97	27.46	31.70	35.22
$\Delta_{ground(S,O)}$	-0.71	-0.05	-0.42	-1.62	-1.58	-1.56	-1.55	-1.55
$\Delta_{ground(O,R)}$	-0.18	-0.60	-1.42	-1.36	-1.32	-1.30	-1.30	-1.29
A_{dif}	6.28	8.04	8.93	10.48	14.09	18.48	22.15	22.16
$A_{ground(S,R)}$	-	-	-	-	-	-	-	-
$A_{boundary,H}$	**6.28**	**8.04**	**8.93**	**10.48**	**14.09**	**18.48**	**22.15**	**22.16**

Table 5.3.24-15: Calculation of A boundary (Fav) (Source: Umweltbundesamt [9])

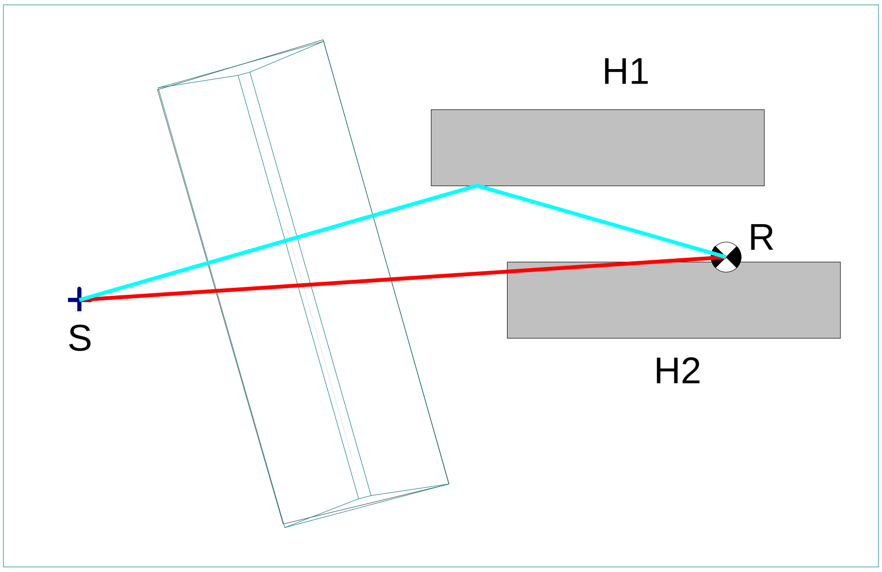
Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000
$\Delta_{dif(S,R)}$	7.10	8.59	10.59	12.99	15.66	18.49	21.41	24.37
$A_{ground,(S,O)}$	-0.96	-0.13	-1.09	-2.79	-2.79	-2.79	-2.79	-2.79
$A_{ground,(O,R)}$	-0.54	-1.28	-2.39	-2.39	-2.39	-2.39	-2.39	-2.39
$\Delta_{dif(S',R)}$	10.51	12.87	15.53	18.36	21.27	24.23	27.22	30.22
$\Delta_{dif(S,R')}$	10.86	13.27	15.96	18.81	21.73	24.70	27.68	30.68
$\Delta_{ground(S,O)}$	-0.66	-0.08	-0.64	-1.61	-1.57	-1.55	-1.54	-1.53
$\Delta_{ground(O,R)}$	-0.35	-0.77	-1.37	-1.30	-1.27	-1.25	-1.24	-1.24
A_{dif}	6.09	7.74	8.59	10.07	12.82	15.69	18.63	21.60
$A_{ground(S,R)}$	-	-	-	-	-	-	-	-
$A_{boundary,H}$	**6.09**	**7.74**	**8.59**	**10.07**	**12.82**	**15.69**	**18.63**	**21.60**

Table 5.3.24-16: Spectral intermediate and final results for the vertical propagation plane (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	
L_W in dB	93	93	93	93	93	93	93	93	
α_{atm}	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.01	0.03	0.07	0.14	0.26	0.68	2.30	8.19	
A_{div} in dB	47.91	47.91	47.91	47.91	47.91	47.91	47.91	47.91	
$A_{boundary,H}$ in dB	6.28	8.04	8.93	10.48	14.09	18.48	22.15	22.16	
$A_{boundary,F}$ in dB	6.09	7.74	8.59	10.07	12.82	15.69	18.63	21.60	**Total**
L_H in dB	38.80	37.02	36.08	34.47	30.75	25.93	20.64	14.74	43.26
L_F in dB	38.99	37.32	36.42	34.88	32.01	28.72	24.16	15.29	43.69
L in dB	38.90	37.17	36.26	34.68	31.42	27.54	22.75	15.02	43.48
A-weighting dB	-26.2	-16.1	-8.6	-3.2	0.0	1.2	1.0	-1.1	
$L_A{}^a$ in dB	**12.70**	**21.07**	**27.66**	**31.48**	**31.42**	**28.74**	**23.75**	**13.92**	**36.56**

5.3.25 TC 24 - Earth wall and house with reflection as sound barrier

Figure 5.3.25-1: Scenario with wall and two buildings H1 and H2 - point of immission before H2 (Source: Umweltbundesamt [9])



In contrast to the previous scenario, the immission point is located on the opposite building. This should automatically lead to the calculation of the now valid reflection.

In this calculation, the strategy plays an essential role in dealing with a sequence of sound barrier earth surveys and houses on lateral diffraction.

The direct sound is blocked both by the earth wall and by the house H2.

Figure 5.3.25-2: Longitudinal section in plane Ev with the direct beam S -> R (Source: Umweltbundesamt [9])

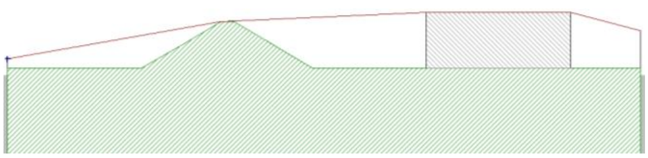


Table 5.3.25-1: Height profiles for the blocked direct sound path for Hom (Source: Umweltbundesamt [9])

z-Profile S-O		z-Profile O-R	
u (m)	z (m)	u (m)	z (m)
0.00	0.00	60.58	0.00
14.46	0.00	68.15	0.00
23.03	5.00		

Table 5.3.25-2: Determination of Gpath (Hom) (Source: Umweltbundesamt [9])

G-Profile S -> O				G-Profile O -> R			
from (m)	to (m)	length (m)	G	from (m)	to (m)	length (m)	G
0.00	14.46	14.46	0	0.00	7.57	7.57	0
14.46	23.03	8.56	1			Gpath	0.00
		Gpath	0.37				

Table 5.3.25-3: z-height profile along the propagation path (Source: Umweltbundesamt [9])

z-Profile S - R		
No.	u (m)	v (m)
1	0.00	0.00
2	14.46	0.00
3	23.03	5.00
4	24.39	5.00
5	32.85	0.00
6	45.10	0.00
7	45.10	6.00
8	60.58	6.00
9	60.58	0.00
10	68.15	0.00

Table 5.3.25-4: Mean ground levels MGL and average ground factors (Hom) (Source: Umweltbundesamt [9])

Parameters	S -> O1	On -> R
a (MGL)	0.18	0.00
b (MGL)	-1.17	0.00
z1	2.13	6.00
z2	1.94	4.00
dp	23.37	7.57
Gpath	0.37	0.00
G'path	0.07	

Table 5.3.25-5: Coordinates of the mirror points (Hom) (Source: Umweltbundesamt [9])

Mirror points	u	v
S' (S -> O)	0.76	-3.20
R' (O -> R)	68.15	-4.00

Table 5.3.25-6: Detour calculation for sound barriers (Source: Umweltbundesamt [9])

Parameters	S -> R		S '-> R		S -> R'		Lateral right		Lateral left	
	Hom	Fav	Hom	Fav	Hom	Fav	Hom	Fav	Hom	Fav
KA1	3	3	3	3	3	3				
KA2	8	8	8	8	8	8				
dir	68.21	68.23	67.77	67.78	68.33	68.35				
dss	23.37	23.37	23.72	23.72	23.37	23.37				
dsr	7.83	7.83	7.83	7.83	12.54	12.54				
e	37.57	37.57	37.57	37.57	37.57	37.57				
z	0.56	0.55	1.36	1.35	5.16	5.14				

Table 5.3.25-7: Calculation of A boundary (Hom) (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000
$\Delta_{dif(S,R)}$	10.18	13.64	16.95	20.02	23.02	26.01	29.00	32.01
$A_{ground,(S,O)}$	-1.05	-0.09	-0.69	-2.79	-2.79	-2.79	-2.79	-2.79
$A_{ground,(O,R)}$	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00
$\Delta_{dif(S',R)}$	13.22	17.14	20.64	23.79	26.82	29.83	32.84	35.85
$\Delta_{dif(S,R')}$	18.53	22.73	26.34	29.53	32.59	35.61	38.62	41.63
$\Delta_{ground(S,O)}$	-0.75	-0.06	-0.46	-1.90	-1.90	-1.89	-1.89	-1.89
$\Delta_{ground(O,R)}$	-1.27	-1.17	-1.14	-1.12	-1.12	-1.11	-1.11	-1.11
A_{dif}	8.16	12.40	15.36	16.99	20.00	22.00	22.00	22.00
$A_{ground(S,R)}$	-	-	-	-	-	-	-	-
$A_{boundary,H}$	**8.16**	**12.40**	**15.36**	**16.99**	**20.00**	**22.00**	**22.00**	**22.00**

Table 5.3.25-8: Calculation of A boundary (Fav) (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000
$\Delta_{dif(S,R)}$	10.11	13.55	16.86	19.93	22.92	25.91	28.91	31.91
$A_{ground,(S,O)}$	-0.98	-0.14	-1.05	-2.79	-2.79	-2.79	-2.79	-2.79
$A_{ground,(O,R)}$	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00
$\Delta_{dif(S',R)}$	13.19	17.10	20.60	23.75	26.79	29.79	32.80	35.81
$\Delta_{dif(S,R')}$	18.52	22.72	26.33	29.52	32.58	35.60	38.61	41.62
$\Delta_{ground(S,O)}$	-0.70	-0.10	-0.70	-1.89	-1.89	-1.88	-1.88	-1.88
$\Delta_{ground(O,R)}$	-1.27	-1.17	-1.13	-1.11	-1.11	-1.10	-1.10	-1.10
A_{dif}	8.15	12.29	15.04	16.92	19.93	22.02	22.02	22.02
$A_{ground(S,R)}$	-	-	-	-	-	-	-	-
$A_{boundary,H}$	**8.15**	**12.29**	**15.04**	**16.92**	**19.93**	**22.02**	**22.02**	**22.02**

Table 5.3.25-9: Spectral intermediate and final results for the vertical propagation plane (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	
L_W in dB	93	93	93	93	93	93	93	93	
α_{atm}	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.01	0.03	0.07	0.13	0.25	0.66	2.24	7.97	
A_{div} in dB	47.68	47.68	47.68	47.68	47.68	47.68	47.68	47.68	
$A_{boundary,H}$ in dB	8.16	12.40	15.36	16.99	20.00	22.00	22.00	22.00	
$A_{boundary,F}$ in dB	8.15	12.29	15.04	16.92	19.93	22.02	22.02	22.02	**Total**
L_H in dB	37.16	32.90	29.89	28.20	25.07	22.67	21.09	15.35	39.75
L_F in dB	37.17	33.00	30.22	28.27	25.14	22.65	21.07	15.33	39.82
L in dB	37.16	32.95	30.06	28.23	25.11	22.66	21.08	15.34	39.79
A-weighting dB	-26.2	-16.1	-8.6	-3.2	0.0	1.2	1.0	-1.1	
$L_A{}^a$ in dB	**10.96**	**16.85**	**21.46**	**25.03**	**25.11**	**23.86**	**22.08**	**14.24**	**31.05**

Table 5.3.25-10: Height profiles for the directly shielded sound path for Hom – Reflection (Source: Umweltbundesamt [9])

z-Profile S-O		z-Profile O-R	
u (m)	z (m)	u (m)	z (m)
0.00	0.00	23.84	5.00
14.13	0.00	32.13	0.00
22.51	5.00	43.53	0.00
		70.74	0.00

Table 5.3.25-11: Height profiles for the directly shielded sound path for Fav – Reflection (Source: Umweltbundesamt [9])

z-Profile S-O		z-Profile O-R	
u (m)	z (m)	u (m)	z (m)
0.00	0.00	22.51	5.00
14.13	0.00	23.84	5.00
22.51	5.00	32.13	0.00
		43.53	0.00
		70.74	0.00

Table 5.3.25-12: Determination of Gpath (Hom) – Reflection (Source: Umweltbundesamt [9])

G-Profile S -> O				G-Profile O -> R			
from (m)	to (m)	length (m)	G	from (m)	to (m)	length (m)	G
0.00	14.13	14.13	0	0.00	8.29	8.29	1
14.13	22.51	8.38	1	8.29	19.70	11.40	0.00
		Gpath	0.372	19.70	46.90	27.21	0.00
						Gpath	0.177

Table 5.3.25-13: Determination of Gpath (Fav) – Reflection (Source: Umweltbundesamt [9])

G-Profile S -> O				G-Profile O -> R			
from (m)	to (m)	length (m)	G	from (m)	to (m)	length (m)	G
0.00	14.13	14.13	0	0.00	9.62	9.62	1
14.13	22.51	8.38	1	9.62	21.02	11.40	0
		Gpath	0.37	21.02	48.23	27.21	0
						Gpath	0.20

Table 5.3.25-14: Mean ground levels MGL and average ground factors (Hom) - Reflection (Source: Umweltbundesamt [9])

Parameters	S -> O1	On -> R
a (MGL)	0.19	-0.05
b (MGL)	-1.17	2.80
z1	2.13	3.38
z2	1.94	4.72
dp	22.86	46.90
Gpath	0.37	0.18
G'path	0.07	

Table 5.3.25-15: Mean ground levels MGL and average ground factors (Fav) - Reflection (Source: Umweltbundesamt [9])

Parameters	S -> O1	On -> R
a (MGL)	0.19	-0.06
b (MGL)	-1.17	3.41
z1	2.13	2.96
z2	1.94	4.90
dp	22.86	48.20
Gpath	0.37	0.20
G'path	0.07	

Table 5.3.25-16: Coordinates of the mirror points (Hom) - Reflection (Source: Umweltbundesamt [9])

Mirror points	u	v
S' (S -> O)	0.78	-3.19
R' (O -> R)	70.27	-5.43

Table 5.3.25-17: Coordinates of the mirror points (Fav) - Reflection (Source: Umweltbundesamt [9])

Mirror points	u	v
S' (S -> O)	0.78	-3.19
R' (O -> R)	70.14	-5.77

Table 5.3.25-18: Detour calculation for sound barriers – Reflection (Source: Umweltbundesamt [9])

Para-meters	S -> R		S '-> R		S -> R'		Lateral right		Lateral left	
	Hom	Fav	Hom	Fav	Hom	Fav	Hom	Fav	Hom	Fav
KA1	3	3	3	3	3	3				
KA2	4	3	4	3	4	3				
dir	70.80	70.82	70.33	70.34	70.56	70.49				
dss	22.86	22.86	23.22	23.22	22.86	22.86				
dsr	46.92	48.24	46.92	48.24	47.59	48.84				
e	1.33	0.00	1.33	0.00	1.33	0.00				
z	0.30	0.29	1.13	1.13	1.22	1.22				

Table 5.3.25-19: Calculation of A boundary (Hom) – Reflection (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000
$\Delta_{dif(S,R)}$	7.18	8.71	10.80	13.49	17.00	21.36	25.56	29.08
$A_{ground,(S,O)}$	-1.01	-0.08	-0.75	-2.79	-2.79	-2.79	-2.79	-2.79
$A_{ground,(O,R)}$	-0.27	-0.94	-2.47	-2.47	-2.47	-2.47	-2.47	-2.47
$\Delta_{dif(S',R)}$	10.58	12.96	15.71	18.82	22.59	27.07	31.31	34.85
$\Delta_{dif(S,R')}$	10.80	13.22	15.98	19.11	22.88	27.37	31.61	35.15
$\Delta_{ground(S,O)}$	-0.70	-0.05	-0.43	-1.62	-1.58	-1.56	-1.55	-1.55
$\Delta_{ground(O,R)}$	-0.18	-0.57	-1.45	-1.38	-1.34	-1.32	-1.32	-1.32
A_{dif}	6.30	8.09	8.93	10.49	14.08	18.48	22.13	22.14
$A_{ground(S,R)}$	-	-	-	-	-	-	-	-
$A_{boundary,H}$	**6.30**	**8.09**	**8.93**	**10.49**	**14.08**	**18.48**	**22.13**	**22.14**

Table 5.3.25-20: Calculation of A boundary (Fav) – Reflection (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000
$\Delta_{dif(S,R)}$	7.12	8.61	10.62	13.02	15.69	18.52	21.44	24.40
$A_{ground,(S,O)}$	-0.95	-0.13	-1.10	-2.79	-2.79	-2.79	-2.79	-2.79
$A_{ground,(O,R)}$	-0.52	-1.21	-2.40	-2.40	-2.40	-2.40	-2.40	-2.40
$\Delta_{dif(S',R)}$	10.55	12.91	15.57	18.40	21.32	24.28	27.26	30.26
$\Delta_{dif(S,R')}$	10.81	13.21	15.90	18.74	21.66	24.63	27.61	30.61
$\Delta_{ground(S,O)}$	-0.65	-0.08	-0.64	-1.61	-1.57	-1.55	-1.54	-1.53
$\Delta_{ground(O,R)}$	-0.34	-0.73	-1.39	-1.33	-1.29	-1.27	-1.26	-1.26
A_{dif}	6.12	7.80	8.59	10.08	12.83	15.70	18.64	21.61
$A_{ground(S,R)}$	-	-	-	-	-	-	-	-
$A_{boundary,H}$	**6.12**	**7.80**	**8.59**	**10.08**	**12.83**	**15.70**	**18.64**	**21.61**

Table 5.3.25-21: Calculation of the A-weighted partial level for the reflected beam (Hom and Fav)– Reflection (Source: Umweltbundesamt [9])

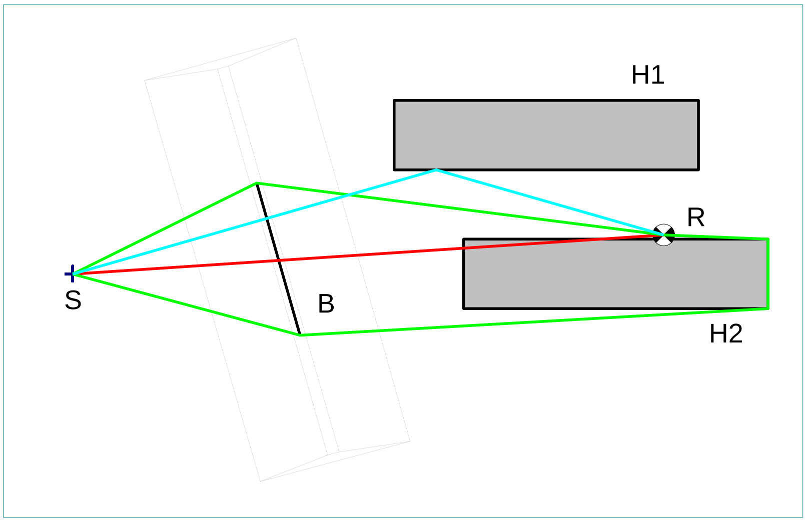
Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	
L_W in dB	93	93	93	93	93	93	93	93	
$dL_{abs,H}$	-0.97	-0.97	-0.97	-0.97	-0.97	-0.97	-0.97	-0.97	
$dL_{retrodif,H}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
$L_{W,H}$ in dB	**92.03**	**92.03**	**92.03**	**92.03**	**92.03**	**92.03**	**92.03**	**92.03**	
$\alpha_{atm,H}$	0.1	0.4	1.0	1.9	3.7	9.7	32.8	116.9	
$A_{atm,H}$ in dB	0.01	0.03	0.07	0.14	0.26	0.68	2.32	8.28	
A_{div} in dB	48.00	48.00	48.00	48.00	48.00	48.00	48.00	48.00	
$A_{boundary,H}$ in dB	6.30	8.09	8.93	10.49	14.08	18.48	22.13	22.14	
L_H in dB	37.72	35.91	35.03	33.41	29.69	24.87	19.58	13.62	
$dL_{abs,F}$	-0.97	-0.97	-0.97	-0.97	-0.97	-0.97	-0.97	-0.97	
$dL_{retrodif,F}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
$L_{W,F}$ in dB	92.03	92.03	92.03	92.03	92.03	92.03	92.03	92.03	
$\alpha_{atm,F}$	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
$A_{atm,F}$ in dB	0.01	0.03	0.07	0.14	0.26	0.68	2.32	8.28	
A_{div} in dB	48.00	48.00	48.00	48.00	48.00	48.00	48.00	48.00	
$A_{boundary,F}$ in dB	6.12	7.80	8.59	10.08	12.83	15.70	18.64	21.61	
L_F in dB	37.90	36.20	35.37	33.81	30.94	27.64	23.07	14.14	
L in dB	37.81	36.06	35.20	33.61	30.36	26.47	21.67	13.89	
A-correction in dB	-26.2	-16.1	-8.6	-3.2	0.0	1.2	1.0	-1.1	**Total**
L_A in dB	**11.61**	**19.96**	**26.60**	**30.41**	**30.36**	**27.67**	**22.67**	**12.79**	**35.50**

Table 5.3.25-22: Calculation of the A-weighted total level (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	Total
LA in dB direct sound	10.96	16.85	21.46	25.03	25.11	23.86	22.08	14.24	31.05
LA in dB reflection	11.61	19.96	26.60	30.41	30.36	27.67	22.67	12.79	35.50
LA in dB	**14.31**	**21.69**	**27.76**	**31.52**	**31.49**	**29.18**	**25.39**	**16.58**	**36.83**

5.3.26 TC 25 - Replacing the earth wall with another sound barrier

Figure 5.3.26-1: Scenario with short barrier (same height as wall in TC 24) (Source: Umweltbundesamt [9])



As shown in the diagram, the earth wall is replaced by a shorter barrier of the same height.

According to the diagram, there are now 4 beam paths to be considered. It is assumed that no side diffraction is taken into account for reflected beam paths.

Table 5.3.26-1: Coordinates of sound barriers (upper edge) (Source: Umweltbundesamt [9])

Barrier No.	x (m)	y (m)	z (m)
1	59.19	24.47	5.0
1	64.17	6.95	5.0

Table 5.3.26-2: Height profiles for the direct and the two lateral ways for Hom (Source: Umweltbundesamt [9])

z-Profile S-O		z-Profile O-R		z-Profile right		z-Profile left	
u (m)	z (m)	u (m)	z (m)	u (m)	z (m)	u (m)	z (m)
0.00	0.00	60.58	0.00	0.00	0.00	0.00	0.00
23.77	0.00	68.15	0.00	27.10	0.00	23.64	0.00
				81.02	0.00	70.83	0.00
				89.03	0.00		
				101.05	0.00		

Table 5.3.26-3: z-height profile along the propagation path (Source: Umweltbundesamt [9])

z-Profile S - R		
No.	u (m)	v (m)
1	0.00	0.00
2	23.77	0.00
3	23.77	5.00
4	23.77	0.00
5	45.10	0.00
6	45.10	6.00
7	60.58	6.00
8	60.58	0.00
9	68.15	0.00

Table 5.3.26-4: Coordinates of the mirror points (Hom) (Source: Umweltbundesamt [9])

Mirror points	u	v
S' (S -> O)	0.00	-1.00
R' (O -> R)	68.15	-4.00

Table 5.3.26-5: Mean ground levels MGL and average ground factors (Hom) (Source: Umweltbundesamt [9])

Parameters	S -> O1	On -> R
a (MGL)	0.00	0.00
b (MGL)	0.00	0.00
z1	1.00	6.00
z2	5.00	4.00
dp	23.77	7.57
Gpath	0.00	0.00
G'path	0.00	

Table 5.3.26-6: Detour calculation for sound barriers (Source: Umweltbundesamt [9])

Para-meters	S -> R		S '-> R		S -> R'		Lateral right		Lateral left	
	Hom	Fav	Hom	Fav	Hom	Fav	Hom	Fav	Hom	Fav
KA1	3	3	3	3	3	3	-	-	-	-
KA2	7	7	7	7	7	7	-	-	-	-
dir	68.21	68.23	68.33	68.35	68.33	68.35	68.21	68.21	68.21	68.21
dss	24.11	24.11	24.52	24.52	24.11	24.11	27.13	27.13	23.66	23.66
dsr	7.83	7.83	7.83	7.83	12.54	12.54	12.03	12.03	47.23	47.23
e	36.83	36.83	36.83	36.83	36.83	36.83	61.98	61.98	0.00	0.00
z	0.55	0.54	0.85	0.83	5.15	5.13	32.92	32.92	2.68	2.68

Table 5.3.26-7: Calculation of A boundary (Hom) (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000
$\Delta_{dif(S,R)}$	10.09	13.54	16.87	19.94	22.94	25.93	28.93	31.93
$A_{ground,(S,O)}$	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00
$A_{ground,(O,R)}$	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00
$\Delta_{dif(S',R)}$	11.48	15.20	18.63	21.75	24.77	27.78	30.78	33.78
$\Delta_{dif(S,R')}$	18.47	22.70	26.32	29.52	32.58	35.60	38.61	41.62
$\Delta_{ground(S,O)}$	-2.62	-2.55	-2.52	-2.51	-2.50	-2.50	-2.50	-2.50
$\Delta_{ground(O,R)}$	-1.27	-1.17	-1.13	-1.11	-1.11	-1.10	-1.10	-1.10
A_{dif}	6.21	9.83	13.22	16.32	19.33	21.40	21.40	21.40
$A_{ground(S,R)}$	-	-	-	-	-	-	-	-
$A_{boundary,H}$	**6.21**	**9.83**	**13.22**	**16.32**	**19.33**	**21.40**	**21.40**	**21.40**

Table 5.3.26-8: Calculation of A boundary (Fav) (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000
$\Delta_{dif(S,R)}$	10.03	13.46	16.78	19.85	22.84	25.83	28.83	31.83
$A_{ground,(S,O)}$	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00
$A_{ground,(O,R)}$	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00
$\Delta_{dif(S',R)}$	11.43	15.14	18.57	21.69	24.71	27.71	30.72	33.72
$\Delta_{dif(S,R')}$	18.46	22.69	26.31	29.51	32.57	35.59	38.60	41.61
$\Delta_{ground(S,O)}$	-2.61	-2.54	-2.51	-2.50	-2.50	-2.49	-2.49	-2.49
$\Delta_{ground(O,R)}$	-1.26	-1.16	-1.12	-1.10	-1.10	-1.09	-1.09	-1.09
A_{dif}	6.15	9.76	13.15	16.24	19.25	21.41	21.42	21.42
$A_{ground(S,R)}$	-	-	-	-	-	-	-	-
$A_{boundary,H}$	**6.15**	**9.76**	**13.15**	**16.24**	**19.25**	**21.41**	**21.42**	**21.42**

Table 5.3.26-9: Spectral intermediate and final results for the vertical propagation plane (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	
L_W in dB	93	93	93	93	93	93	93	93	
α_{atm}	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.01	0.03	0.07	0.13	0.25	0.66	2.24	7.97	
A_{div} in dB	47.68	47.68	47.68	47.68	47.68	47.68	47.68	47.68	
$A_{boundary,H}$ in dB	6.21	9.83	13.22	16.32	19.33	21.40	21.40	21.40	
$A_{boundary,F}$ in dB	6.15	9.76	13.15	16.24	19.25	21.41	21.42	21.42	**Total**
L_H in dB	39.11	35.47	32.03	28.87	25.74	23.27	21.69	15.95	41.70
L_F in dB	39.16	35.53	32.11	28.95	25.82	23.25	21.67	15.93	41.76
L in dB	39.13	35.50	32.07	28.91	25.78	23.26	21.68	15.94	41.73
A-weighting dB	-26.2	-16.1	-8.6	-3.2	0.0	1.2	1.0	-1.1	
$L_A{}^a$ in dB	**12.93**	**19.40**	**23.47**	**25.71**	**25.78**	**24.46**	**22.68**	**14.84**	**31.97**

Table 5.3.26-10: Calculation of the unweighted partial level for the right detour (Hom) (Source: Umweltbundesamt [9])

Lateral right H									
Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	
L_W in dB	93	93	93	93	93	93	93	93	
α-atm(10°,70%)	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.01	0.04	0.11	0.19	0.37	0.98	3.31	11.82	
A_{div} in dB	47.68	47.68	47.68	47.68	47.68	47.68	47.68	47.68	
$A_{ground,H}$ in dB	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	
$\Delta_{dif,H}$ in dB	27.47	31.25	34.53	37.62	40.65	43.66	46.67	49.68	
A_H in dB	72.16	75.97	79.32	82.49	85.69	89.32	94.66	106.18	**Total**
L_H in dB	**20.84**	**17.03**	**13.68**	**10.51**	**7.31**	**3.68**	**-1.66**	**-13.18**	**23.32**

Table 5.3.26-11: Calculation of the unweighted partial level for the left detour (Hom) (Source: Umweltbundesamt [9])

Lateral left H									
Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	
L_W in dB	93	93	93	93	93	93	93	93	
α-atm(10°,70%)	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.01	0.03	0.07	0.14	0.26	0.69	2.32	8.29	
A_{div} in dB	47.68	47.68	47.68	47.68	47.68	47.68	47.68	47.68	
$A_{ground,H}$ in dB	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	
$\Delta_{dif,H}$ in dB	13.59	16.27	19.12	22.05	25.02	28.01	31.01	34.02	
A_H in dB	58.27	60.98	63.87	66.87	69.96	73.37	78.01	86.98	**Total**
L_H in dB	**34.73**	**32.02**	**29.13**	**26.13**	**23.04**	**19.63**	**14.99**	**6.02**	**37.87**

Table 5.3.26-12: Calculation of the A-weighted total level (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	
L_H(vert) in dB	39.11	35.47	32.03	28.87	25.74	23.27	21.69	15.95	
L_H (right) in dB	20.84	17.03	13.68	10.51	7.31	3.68	-1.66	-13.18	
L_H (left) in dB	34.73	32.02	29.13	26.13	23.04	19.63	14.99	6.02	
L_H(tot) in dB	40.50	37.13	33.87	30.77	27.65	24.86	22.55	16.37	
L_H(vert) in dB	39.16	35.53	32.11	28.95	25.82	23.25	21.67	15.93	
L_F(right) in dB	20.84	17.03	13.68	10.51	7.31	3.68	-1.66	-13.18	
L_F(left) in dB	34.73	32.02	29.13	26.13	23.04	19.63	14.99	6.02	
L_F(tot) in dB	40.54	37.18	33.92	30.82	27.70	24.85	22.53	16.36	**Total**
L in dB	40.52	37.15	33.89	30.79	27.68	24.85	22.54	16.37	**43.27**
A-correction in dB	-26.2	-16.1	-8.6	-3.2	0	1.2	1	-1.1	
L_A in dB	**14.32**	**21.05**	**25.29**	**27.59**	**27.68**	**26.05**	**23.54**	**15.27**	**33.65**

Table 5.3.26-13: Mean ground levels MGL and average ground factors (Hom) - Reflection (Source: Umweltbundesamt [9])

Parameters	S -> O1	On -> R	S->R ri	S->R le
a (MGL)	0.00	0.00	-	-
b (MGL)	0.00	0.00	-	-
z1	1.00	5.00	-	-
z2	5.00	4.00	-	-
dp	23.24	47.49	-	-
Gpath	0.00	0.00	-	-
G'path	0.00		-	-

Table 5.3.26-14: Detour calculation for sound barriers – Reflection (Source: Umweltbundesamt [9])

Para-meters	S -> R		S '-> R		S -> R'		Lateral right		Lateral left	
	Hom	Fav	Hom	Fav	Hom	Fav	Hom	Fav	Hom	Fav
KA1	3	3	3	3	3	3				
KA2	3	3	3	3	3	3				
dir	70.80	70.82	70.92	70.93	70.92	70.93				
dss	23.59	23.59	24.01	24.01	23.59	23.59				
dsr	47.51	47.51	47.51	47.51	48.34	48.35				
e	0.00	0.00	0.00	0.00	0.00	0.00				
z	0.29	0.28	0.60	0.59	1.01	1.00				

Table 5.3.26-15: Calculation of A boundary (Hom)- Reflection (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000
$\Delta_{dif(S,R)}$	7.11	8.60	10.60	13.01	15.68	18.51	21.42	24.39
$A_{ground,(S,O)}$	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00
$A_{ground,(O,R)}$	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00
$\Delta_{dif(S',R)}$	8.70	10.71	13.12	15.80	18.64	21.56	24.52	27.51
$\Delta_{dif(S,R')}$	10.21	12.52	15.15	17.95	20.86	23.82	26.80	29.80
$\Delta_{ground(S,O)}$	-2.56	-2.44	-2.34	-2.27	-2.23	-2.21	-2.20	-2.20
$\Delta_{ground(O,R)}$	-2.20	-2.03	-1.90	-1.82	-1.78	-1.75	-1.74	-1.74
A_{dif}	2.34	4.14	6.37	8.91	11.66	14.54	17.48	20.45
$A_{ground(S,R)}$	-	-	-	-	-	-	-	-
$A_{boundary,H}$	**2.34**	**4.14**	**6.37**	**8.91**	**11.66**	**14.54**	**17.48**	**20.45**

Table 5.3.26-16: Calculation of A boundary (Fav) – Reflection (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000
$\Delta_{dif(S,R)}$	7.05	8.51	10.49	12.88	15.54	18.36	21.28	24.24
$A_{ground,(S,O)}$	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00
$A_{ground,(O,R)}$	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00
$\Delta_{dif(S',R)}$	8.66	10.65	13.06	15.74	18.57	21.49	24.45	27.44
$\Delta_{dif(S,R')}$	10.18	12.48	15.11	17.91	20.82	23.77	26.76	29.75
$\Delta_{ground(S,O)}$	-2.56	-2.43	-2.32	-2.26	-2.22	-2.20	-2.19	-2.18
$\Delta_{ground(O,R)}$	-2.20	-2.02	-1.89	-1.81	-1.76	-1.74	-1.72	-1.72
A_{dif}	2.29	4.07	6.28	8.82	11.56	14.43	17.37	20.34
$A_{ground(S,R)}$	-	-	-	-	-	-	-	-
$A_{boundary,H}$	**2.29**	**4.07**	**6.28**	**8.82**	**11.56**	**14.43**	**17.37**	**20.34**

Table 5.3.26-17: Calculation of the A-weighted partial level for the reflected be (Source: Umweltbundesamt [9])am (Hom and Fav)– Reflection (Source: Umweltbundesamt [9])

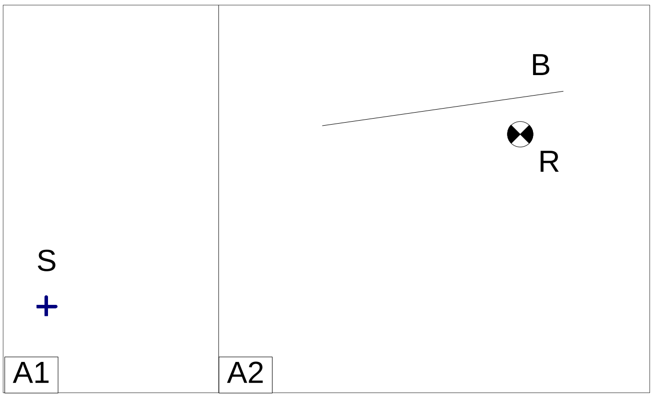
Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	
L_W in dB	93	93	93	93	93	93	93	93	
$dL_{abs,H}$	-0.97	-0.97	-0.97	-0.97	-0.97	-0.97	-0.97	-0.97	
$dL_{retrodif,H}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
$L_{W,H}$ in dB	**92.03**	**92.03**	**92.03**	**92.03**	**92.03**	**92.03**	**92.03**	**92.03**	
$\alpha_{atm,H}$	0.1	0.4	1.0	1.9	3.7	9.7	32.8	116.9	
$A_{atm,H}$ in dB	0.01	0.03	0.07	0.14	0.26	0.68	2.32	8.28	
A_{div} in dB	48.00	48.00	48.00	48.00	48.00	48.00	48.00	48.00	
$A_{boundary,H}$ in dB	2.34	4.14	6.37	8.91	11.66	14.54	17.48	20.45	
L_H in dB	41.68	39.86	37.59	34.98	32.11	28.81	24.23	15.30	
$dL_{abs,F}$	-0.97	-0.97	-0.97	-0.97	-0.97	-0.97	-0.97	-0.97	
$dL_{retrodif,F}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
$L_{W,F}$ in dB	92.03	92.03	92.03	92.03	92.03	92.03	92.03	92.03	
$\alpha_{atm,F}$	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
$A_{atm,F}$ in dB	0.01	0.03	0.07	0.14	0.26	0.68	2.32	8.28	
A_{div} in dB	48.00	48.00	48.00	48.00	48.00	48.00	48.00	48.00	
$A_{boundary,F}$ in dB	2.29	4.07	6.28	8.82	11.56	14.43	17.37	20.34	
L_F in dB	41.73	39.93	37.67	35.08	32.21	28.92	24.34	15.41	
L in dB	41.70	39.90	37.63	35.03	32.16	28.86	24.29	15.36	
A-correction in dB	-26.2	-16.1	-8.6	-3.2	0.0	1.2	1.0	-1.1	**Total**
L_A in dB	**15.50**	**23.80**	**29.03**	**31.83**	**32.16**	**30.06**	**25.29**	**14.26**	**37.50**

Table 5.3.26-18: Calculation of the A-weighted total level (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	Total
LA in dB direct sound	14.32	21.05	25.29	27.59	27.68	26.05	23.54	15.27	**33.65**
LA in dB reflection	15.50	23.80	29.03	31.83	32.16	30.06	25.29	14.26	**37.50**
LA in dB	**17.96**	**25.65**	**30.56**	**33.22**	**33.48**	**31.52**	**27.51**	**17.80**	**39.00**

5.3.27 TC 26 - Road source with influence of retro diffraction

Figure 5.3.27-1: Wall B in reflection condition (S source, R immission point, B wall, A1 area with G=0.9, A2 area with G=0.5) (Source: Umweltbundesamt [9])



The street source (Gs = 0) is located at an area with G = 0.9. The heights of source S, reflector B and point of immission R are selected in such a way that the influence of retro diffraction plays a significant role and can therefore be tested.

Table 5.3.27-1: Coordinates of source S and point of immission R (Source: Umweltbundesamt [9])

Point	x (m)	y (m)	z (abs) (m)
S	10	10	0.05
R	120	50	8

Table 5.3.27-2: Coordinates of sound barriers (upper edge) (Source: Umweltbundesamt [9])

Barrier No.	x (m)	y (m)	z (m)
1	74.00	52.00	6.0
1	130.00	60.00	8.0

Table 5.3.27-3: Ground attenuation (relevant if no diffraction) (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000
w (H)	2,4E-05	1,3E-04	7,6E-04	0.00	0.02	0.13	0.69	3.59
C_f (H)	117.66	120.03	128.73	135.82	80.22	14.03	1.47	0.28
$A_{ground,H}$	**-2.06**	**-2.06**	**-2.06**	**-2.06**	**-2.06**	**-2.06**	**-0.92**	**2.74**
w (F)	0.00	0.00	0.00	0.03	0.14	0.75	3.72	16.87
C_f (F)	120.50	129.83	134.52	73.80	12.01	1.34	0.27	0.06
$A_{ground,F}$	**-2.06**	**-2.06**	**-2.06**	**-2.06**	**-2.06**	**2.02**	**-1.82**	**-2.06**

Table 5.3.27-4: Spectral intermediate and final results for the vertical propagation plane (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	
L_W in dB	93	93	93	93	93	93	93	93	
α_{atm}	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.01	0.05	0.12	0.23	0.43	1.13	3.84	13.71	
A_{div} in dB	52.39	52.39	52.39	52.39	52.39	52.39	52.39	52.39	
$A_{boundary,H}$ in dB	-2.06	-2.06	-2.06	-2.06	-2.06	-2.06	-0.92	2.74	
$A_{boundary,F}$ in dB	-2.06	-2.06	-2.06	-2.06	-2.06	2.02	-1.82	-2.06	**Total**
L_H in dB	42.66	42.63	42.55	42.45	42.25	41.54	37.68	24.16	50.39
L_F in dB	42.66	42.63	42.55	42.45	42.25	37.46	38.59	28.96	50.11
L in dB	42.66	42.63	42.55	42.45	42.25	39.96	38.16	27.19	50.26
A-weighting dB	-26.2	-16.1	-8.6	-3.2	0.0	1.2	1.0	-1.1	
$L_A{}^a$ in dB	**16.46**	**26.53**	**33.95**	**39.25**	**42.25**	**41.16**	**39.16**	**26.09**	**46.98**

Table 5.3.27-5: Ground attenuation (relevant if no diffraction) - Reflection (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000
w (H)	2,7E-05	1,5E-04	8,5E-04	0.00	0.03	0.14	0.77	3.97
C_f (H)	122.41	125.22	135.04	139.66	75.50	11.83	1.31	0.25
$A_{ground,H}$	**-2.02**	**-2.02**	**-2.02**	**-2.02**	**-2.02**	**-2.02**	**0.02**	**3.17**
w (F)								
C_f (F)								
$A_{ground,F}$								

Table 5.3.27-6: Calculation of the A-weighted partial level for the reflected beam (Hom and Fav)– Reflection (Source: Umweltbundesamt [9])

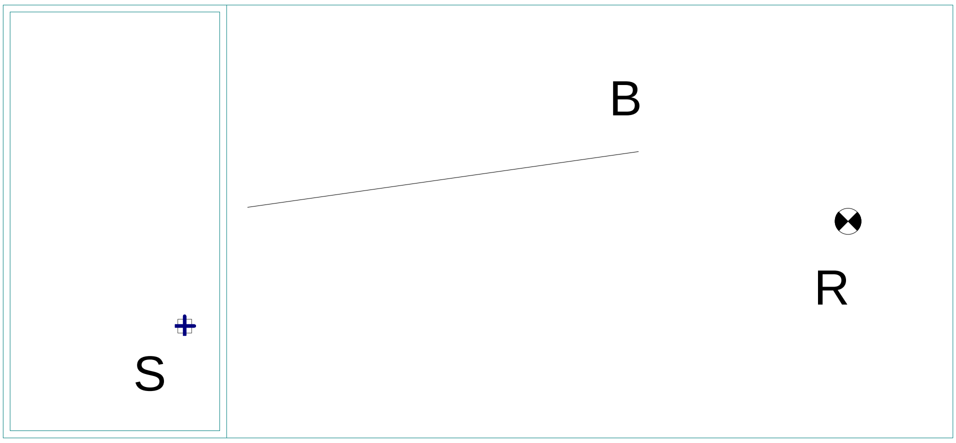
Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	
L_W in dB	93	93	93	93	93	93	93	93	
$dL_{abs,H}$	-0.46	-0.97	-1.55	-2.22	-3.01	-3.98	-5.23	-3.01	
$dL_{retrodif,H}$	4.73	4.68	4.59	4.40	4.00	3.07	0.24	0.00	
$L_{W,H}$ in dB	**87.82**	**87.35**	**86.86**	**86.38**	**85.99**	**85.95**	**87.53**	**89.99**	
$\alpha_{atm,H}$	0.1	0.4	1.0	1.9	3.7	9.7	32.8	116.9	
$A_{atm,H}$ in dB	0.01	0.05	0.13	0.24	0.45	1.18	4.00	14.25	
A_{div} in dB	52.72	52.72	52.72	52.72	52.72	52.72	52.72	52.72	
$A_{boundary,H}$ in dB	-2.02	-2.02	-2.02	-2.02	-2.02	-2.02	0.02	3.17	
L_H in dB	37.10	36.60	36.03	35.44	34.84	34.07	30.79	19.85	
$dL_{abs,F}$									
$dL_{retrodif,F}$									
$L_{W,F}$ in dB									
$\alpha_{atm,F}$									
$A_{atm,F}$ in dB									
A_{div} in dB									
$A_{boundary,F}$ in dB									
L_F in dB									
L in dB	34.09	33.59	33.02	32.43	31.83	31.06	27.78	16.88	
A-correction in dB	-26.2	-16.1	-8.6	-3.2	0.0	1.2	1.0	-1.1	**Total**
L_A in dB	**7.89**	**17.49**	**24.42**	**29.23**	**31.83**	**32.26**	**28.78**	**15.78**	**37.14**

Table 5.3.27-7: Calculation of the A-weighted total level (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	Total
LA in dB direct sound	16.46	26.53	33.95	39.25	42.25	41.16	39.16	26.09	46.98
LA in dB reflection	7.89	17.49	24.42	29.23	31.83	32.26	28.78	15.78	37.14
LA in dB	**17.03**	**27.04**	**34.41**	**39.66**	**42.62**	**41.69**	**39.54**	**26.48**	**47.41**

5.3.28 TC 27 - Road source in flat cut with retro diffraction

Figure 5.3.28-1: Wall B in reflection condition (S source, R immission point, B wall) (Source: Umweltbundesamt [9])



Also in this example retro diffraction as well as the examination of the Rayleigh Criterion play a substantial role.

Table 5.3.28-1: Coordinates of source S and point of immission R (Source: Umweltbundesamt [9])

Point	x (m)	y (m)	z (abs) (m)
S	105	35	-0.45
R	200	50	4

Table 5.3.28-2: Contour lines to describe the ground model (Source: Umweltbundesamt [9])

No.	x1 (m)	y1 (m)	z1 (m)	x2 (m)	y2 (m)	z2 (m)
1	111	20	0	111	80	0
2	111	80	0	215	80	0
3	215	80	0	215	20	0
4	215	20	0	111	20	0
5	80	20	-0.5	80	80	-0.5
6	80	80	-0.5	110	80	-0.5
7	110	80	-0.5	110	20	-0.5
8	110	20	-0.5	80	20	-0.5

Table 5.3.28-3: Mean ground levels MGL and average ground factors (Hom) (Source: Umweltbundesamt [9])

Parameters	S -> O1	On -> R
a (MGL)	0.04	0.00
b (MGL)	-0.57	0.00
z1	0.12	0.00
z2	0.35	4.00
dp	6.09	90.10
Gpath	1.00	1.00
G'path	0.44	

Table 5.3.28-4: Mean ground levels MGL and average ground factors (Fav) (Source: Umweltbundesamt [9])

Parameters	S -> R	S -> O1	On -> R	S->R ri	S->R le
a (MGL)	0.00	0.04	0.00	-	-
b (MGL)	-0.11	-0.57	0.00	-	-
z1	0.00	0.12	0.00	-	-
z2	3.95	0.35	4.00	-	-
dp	96.18	6.09	90.10	-	-
Gpath	1.00	1.00	1.00	-	-
G'path	0.81	0.44		-	-

Table 5.3.28-5: Coordinates of the mirror points (Hom) (Source: Umweltbundesamt [9])

Mirror points	u	v
S' (S -> R)	-	-
R' (S -> R)	-	-
S' (S -> O)	0.01	-0.69
R' (O -> R)	96.18	-4.00

Mirror points	u	v
S' (S -> R)	0.00	0.23
R' (S -> R)	96.19	-3.89
S' (S -> O)	0.01	-0.69
R' (O -> R)	96.18	-4.00

Table 5.3.28-6: Coordinates of the mirror points (Fav) (Source: Umweltbundesamt [9])

Mirror points	u	v
S' (S -> R)	0.00	0.23
R' (S -> R)	96.19	-3.89
S' (S -> O)	0.01	-0.69
R' (O -> R)	96.18	-4.00

Table 5.3.28-7: Detour calculation for sound barriers (Source: Umweltbundesamt [9])

Parameters	S -> R		S '-> R		S -> R'		Lateral right		Lateral left	
	Hom	Fav	Hom	Fav	Hom	Fav	Hom	Fav	Hom	Fav
KA1	3	3	3	3	3	3				
KA2	3	3	3	3	3	3				
dir	96.280	96.317	96.282	96.320	96.242	96.280				
dss	6.091	6.091	6.105	6.105	6.091	6.091				
dsr	90.191	90.222	90.191	90.222	90.191	90.222				
e	0.000	0.000	0.000	0.000	0.000	0.000				
z	0.003	-0.004	0.013	0.007	0.040	0.033				

Table 5.3.28-8: Sound barrier values for testing the Rayleigh Criterion (Source: Umweltbundesamt [9])

Para-meters	Hom	Fav				
		63	125	250	500	1000
KA		3.00	3.00	3.00	3.00	3
-λ/20		-0.27	-0.14	-0.07	-0.03	-0.017
S-R		96.32	96.32	96.32	96.32	96.317032
dss (S-D-R)		6.09	6.09	6.09	6.09	6.0909872
dsr (S-D-R)		90.22	90.22	90.22	90.22	90.221924
δ_D		0.00	0.00	0.00	0.00	-0.0041199
δ_D > -λ/20 ?		+	+	+	+	+
S*-R*		96.262	96.262352	96.262352	96.262352	96.262352
dss (S*-D-R*)		6.1046	6.1045718	6.1045718	6.1045718	6.1045718
dsr (S*-D-R*)		90.222	90.221924	90.221924	90.221924	90.221924
δ_D*		0.0641	0.0641403	0.0641403	0.0641403	0.0641403
λ/4-δ_D*		1.2851	0.6158597	0.2758597	0.1058597	0.0208597
δ_D > (λ/4 - δD*) ?		-	-	-	-	-
R-criterion fulfilled?		-	-	-	-	-

Table 5.3.28-9: Spectral intermediate and final results for the vertical propagation plane (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	
L_W in dB	93	93	93	93	93	93	93	93	
α_{atm}	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.01	0.04	0.10	0.19	0.35	0.93	3.16	11.25	
A_{div} in dB	50.67	50.67	50.67	50.67	50.67	50.67	50.67	50.67	
$A_{boundary,H}$ in dB	3.12	3.17	3.26	3.42	6.26	8.92	12.00	9.33	
$A_{boundary,F}$ in dB	-0.56	-0.56	-0.56	-0.56	4.95	8.63	-0.27	-0.56	**Total**
L_H in dB	39.19	39.12	38.97	38.72	35.72	32.48	27.17	21.75	45.80
L_F in dB	42.88	42.85	42.79	42.71	37.03	32.77	39.44	31.64	49.71
L in dB	41.42	41.38	41.29	41.16	36.42	32.62	36.68	29.05	48.18
A-weighting dB	-26.2	-16.1	-8.6	-3.2	0.0	1.2	1.0	-1.1	
$L_A{}^a$ in dB	**15.22**	**25.28**	**32.69**	**37.96**	**36.42**	**33.82**	**37.68**	**27.95**	**43.38**

Table 5.3.28-10: Mean ground levels MGL and averaged ground factors (Hom) - Reflection (Source: Umweltbundesamt [9])

Parameters	S -> O1	On -> R
a (MGL)	0.03	0.00
b (MGL)	-0.57	0.00
z1	0.12	0.00
z2	0.35	4.00
dp	6.65	94.01
Gpath	1.00	1.00
G'path	0.48	

Table 5.3.28-11: Coordinates of the mirror points (Fav) - Reflection (Source: Umweltbundesamt [9])

Mirror points	u	v
S' (S -> R)	0.00	0.22
R' (S -> R)	100.66	-3.89
S' (S -> O)	0.01	-0.69
R' (O -> R)	100.65	-4.00

Table 5.3.28-12: Detour calculation for sound barriers – Reflection (Source: Umweltbundesamt [9])

Para-meters	S -> R		S '-> R		S -> R'		Lateral right		Lateral left	
	Hom	Fav	Hom	Fav	Hom	Fav	Hom	Fav	Hom	Fav
KA1	3	3	3	3	3	3				
KA2	3	3	3	3	3	3				
dir	100.746	100.789	100.749	100.792	100.710	100.753				
dss	6.651	6.651	6.664	6.664	6.651	6.651				
dsr	94.097	94.132	94.097	94.132	94.097	94.132				
e	0.000	0.000	0.000	0.000	0.000	0.000				
z	0.002	-0.006	0.012	0.004	0.038	0.030				

Table 5.3.28-13: Sound barrier values for testing the Rayleigh Criterion – Reflection (Source: Umweltbundesamt [9])

Parameters	Hom	Fav				
		63	125	250	500	1000
KA		3.00	3.00	3.00	3.00	3
-λ/20		-0.27	-0.14	-0.07	-0.03	-0.017
S-R		100.79	100.79	100.79	100.79	100.78889
dss (S-D-R)		6.65	6.65	6.65	6.65	6.6513782
dsr (S-D-R)		94.13	94.13	94.13	94.13	94.131584
δ_D		-0.01	-0.01	-0.01	-0.01	-0.0059204
δ_D > -λ/20 ?		+	+	+	+	+
S*-R*		100.74	100.73697	100.73697	100.73697	100.73697
dss (S*-D-R*)		6.6638	6.6638231	6.6638231	6.6638231	6.6638231
dsr (S*-D-R*)		94.132	94.131592	94.131592	94.131592	94.131592
δ_D*		0.0584	0.0584488	0.0584488	0.0584488	0.0584488
λ/4-δ_D*		1.2908	0.6215512	0.2815512	0.1115512	0.0265512
δ_D > (λ/4 - δD*) ?		-	-	-	-	-
R-criterion fulfilled?		-	-	-	-	-

Table 5.3.28-14: Calculation of the unweighted partial level for the reflected beam (Hom) - reflection (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	53
L_W in dB	93	93	93	93	93	93	93	93	
dL_{abs}	-0.46	-0.97	-1.55	-2.22	-3.01	-3.98	-5.23	-3.01	
$dL_{retrodif}$	3.85	2.70	0.00	0.00	0.00	0.00	0.00	0.00	
L_W in dB	**88.69**	**89.33**	**91.45**	**90.78**	**89.99**	**89.02**	**87.77**	**89.99**	
α_{atm}	0.1	0.4	1.0	1.9	3.7	9.7	32.8	116.9	
A_{atm} in dB	0.01	0.04	0.11	0.19	0.37	0.97	3.30	11.78	
A_{div} in dB	51.06	51.06	51.06	51.06	51.06	51.06	51.06	51.06	
$A_{boundary,H}$ in dB	3.23	3.27	3.34	3.48	6.52	9.88	12.53	8.92	**Total**
L_H in dB	34.38	34.96	36.94	36.05	32.04	27.11	20.87	18.23	42.34

Table 5.3.28-15: Calculation of the unweighted partial level for the reflected beam (Fav) - Reflection (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	
L_W in dB	93	93	93	93	93	93	93	93	
dL_{abs}	-0.46	-0.97	-1.55	-2.22	-3.01	-3.98	-5.23	-3.01	
$dL_{retrodif}$	4.23	3.62	2.05	0.00	0.00	0.00	0.00	0.00	
L_W in dB	**88.31**	**88.41**	**89.40**	**90.78**	**89.99**	**89.02**	**87.77**	**89.99**	
α_{atm}	0.1	0.4	1.0	1.9	3.7	9.7	32.8	116.9	
A_{atm} in dB	0.01	0.04	0.11	0.19	0.37	0.97	3.30	11.78	
A_{div} in dB	51.06	51.06	51.06	51.06	51.06	51.06	51.06	51.06	
$A_{boundary,F}$ in dB	-0.45	-0.45	-0.45	-0.45	5.34	7.43	0.34	-0.45	**Total**
L_F in dB	37.69	37.75	38.68	39.97	33.22	29.55	33.06	27.60	45.41

Table 5.3.28-16: Calculation of the A-weighted total level (Source: Umweltbundesamt [9])

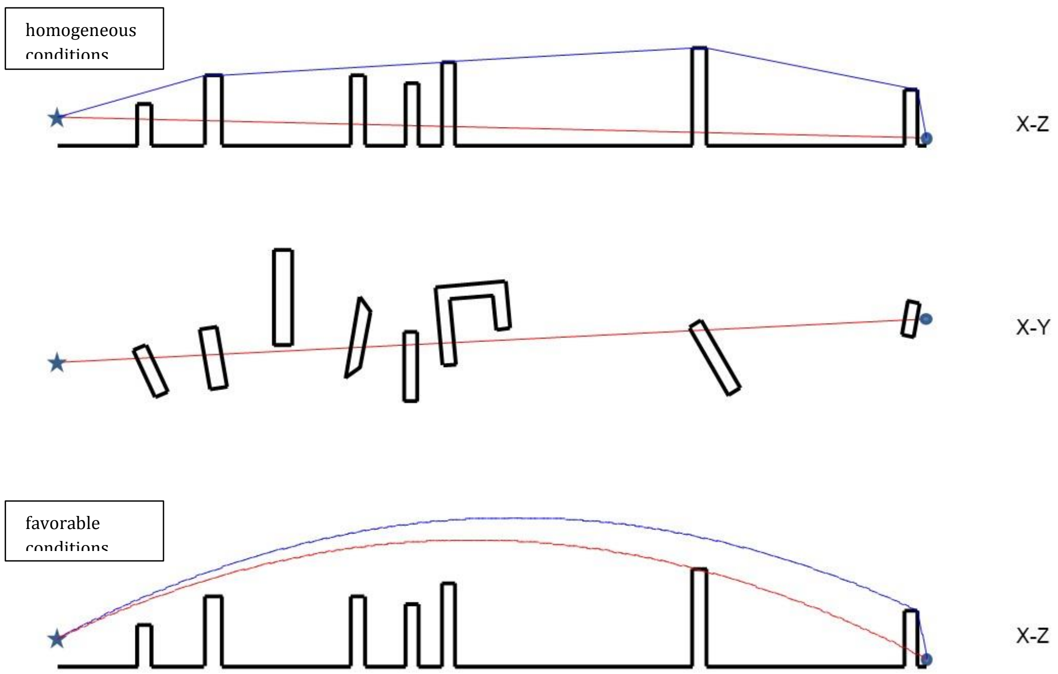
f in Hz->	63	125	250	500	1000	2000	4000	8000	Total
LA in dB direct sound	15.22	25.28	32.69	37.96	36.42	33.82	37.68	27.95	43.38
LA in dB reflection	10.14	20.48	29.30	35.24	32.67	29.70	31.30	23.96	39.39
LA in dB	**16.39**	**26.52**	**34.33**	**39.82**	**37.95**	**35.25**	**38.58**	**29.41**	**44.84**

5.3.29 TC 28 - Propagation over long distances with multiple sound barriers

This test case deals with the newly defined procedure for multiple sound barriers under favorable conditions.

The figure shows the x-y floor plan with the building floor plans in the middle, the u-z view with the - blocked - direct beam (red) and the detour beam on which the calculation for homogeneous conditions is based in the upper part and the same representation for favorable conditions in the lower part.

Figure 5.3.29-1: Building arrangement with beam paths under homogeneous and favorable conditions (Source: Umweltbundesamt [9])



This test case covers most of the problems encountered with the new method of calculating a multiple diffraction under favorable propagation conditions.

Table 5.3.29-1: Coordinates of source S and point of immission R (Source: Umweltbundesamt [9])

Point	x (m)	y (m)	z (abs) (m)
S	0	50	4
R	1000	100	1

Table 5.3.29-2: Constant parameters (Meteo etc.) (Source: Umweltbundesamt [9])

p %	50
rF %	70
T °C	10
Gs	0

Table 5.3.29-3: Unweighted octave band - Sound power level (Source: Umweltbundesamt [9])

Octave band center frequency (Hz)							
63	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
120	120	120	120	120	120	120	120

Table 5.3.29-4: Coordinates of the houses (Source: Umweltbundesamt [9])

Building No.	Corner No.	x (m)	y (m)	z (abs) (m)
1	1	113.0	10.0	6.0
1	2	127.0	16.0	6.0
1	3	102.0	70.0	6.0
1	4	88.0	64.0	6.0
2	5	176.0	19.0	10.0
2	6	164.0	88.0	10.0
2	7	184.0	91.0	10.0
2	8	196.0	22.0	10.0
3	9	250.0	70.0	14.0
3	10	250.0	180.0	14.0
3	11	270.0	180.0	14.0
3	12	270.0	70.0	14.0
4	13	332	32	10
4	14	348	126	10
4	15	361	108	10
4	16	349	44	10
5	17	400	5	9
5	18	400	85	9
5	19	415	85	9
5	20	415	5	9
6	21	444	47	12
6	22	436	136	12
6	23	516	143	12
6	24	521	89	12
6	25	506	87	12
6	26	502	127	12
6	27	452	123	12
6	28	459	48	12
7	29	773	12	14
7	30	728	90	14
7	31	741	98	14
7	32	786	20	14
8	33	972	82	8
8	34	979	121	8
8	35	993	118	8
8	36	986	79	8

Table 5.3.29-5: z-height profile along the propagation path (Source: Umweltbundesamt [9])

z-Profile S - R		
No.	u (m)	v (m)
1	0.00	0.00
2	92.46	0.00
3	92.46	6.00
4	108.88	6.00
5	108.88	0.00
6	169.35	0.00
7	169.35	10.00
8	189.72	10.00
9	189.72	0.00
10	338.36	0.00
11	338.36	10.00
12	353.88	10.00
13	353.88	0.00
14	400.50	0.00
15	400.50	9.00
16	415.52	9.00
17	415.52	0.00
18	442.30	0.00
19	442.30	12.00
20	457.25	12.00
21	457.25	0.00
22	730.93	0.00
23	730.93	14.00
24	748.07	14.00
25	748.07	0.00
26	976.22	0.00
27	976.22	8.00
28	990.91	8.00
29	990.91	0.00
30	1001.25	0.00

Table 5.3.29-6: Height profiles for the direct and the two lateral ways for Hom (Source: Umweltbundesamt [9])

z-Profile S-O		z-Profile O-R		z-Profile right		z-Profile left	
u (m)	z (m)	u (m)	z (m)	u (m)	z (m)	u (m)	z (m)
0.00	0.00	990.91	0.00	0.00	0.00	0.00	0.00
92.46	0.00	1001.25	0.00	119.87	0.00	168.35	0.00
92.46	6.00			406.92	0.00	256.16	0.00
108.88	6.00			421.92	0.00	256.16	14.00
108.88	0.00			779.98	0.00	276.58	14.00
169.35	0.00			1003.27	0.00	276.58	0.00
				1028.52	0.00	356.23	0.00
						444.80	0.00
						525.10	0.00
						988.62	0.00
						1002.94	0.00
						1022.26	0.00

Table 5.3.29-7: Mean ground levels MGL and averaged ground factors (Hom) (Source: Umweltbundesamt [9])

Parameters	S -> O1	On -> R	S->R ri	S->R le
a (MGL)	0.00	0.00	0.00	0.00
b (MGL)	0.25	0.00	0.00	0.68
z1	3.75	8.00	4.00	3.32
z2	9.09	1.00	1.00	1.12
dp	169.37	10.34	1028.52	1022.26
Gpath	0.45	0.50	0.50	0.49
G'path	0.20		0.50	0.49

Table 5.3.29-8: Coordinates of the mirror points (Hom) (Source: Umweltbundesamt [9])

Mirror points	u	v
S' (S -> O)	0.03	-3.50
R' (O -> R)	1001.25	-1.00

Table 5.3.29-9: Mean ground levels MGL and average ground factors (Fav) (Source: Umweltbundesamt [9])

Parameters	S -> O1	On -> R	S->R ri	S->R le
a (MGL)	0.00	0.00	0.00	0.00
b (MGL)	1.33	0.00	1.19	1.67
z1	2.67	8.00	2.81	2.33
z2	7.05	1.00	1.28	1.14
dp	990.91	10.34	1022.47	1015.21
Gpath	0.44	0.50	0.47	0.46
G'path	0.44		0.47	0.46

Table 5.3.29-10: Coordinates of the mirror points (Fav) (Source: Umweltbundesamt [9])

Mirror points	u	v
S' (S -> O)	0.00	-1.35
R' (O -> R)	1001.25	-1.00

Table 5.3.29-11: Detour calculation for sound barriers (Source: Umweltbundesamt [9])

Para-meters	S -> R		S '-> R		S -> R'		Lateral right		Lateral left	
	Hom	Fav	Hom	Fav	Hom	Fav	Hom	Fav	Hom	Fav
KA1	7	28	7	28	7	28	-	-	-	-
KA2	28	28	28	28	28	28	-	-	-	-
dir	1001.25	1001.91	1001.23	1001.91	1001.26	1001.91	1001.25	1001.25	1001.25	1001.25
dss	169.46	991.55	169.86	991.59	169.46	991.55	119.87	773.94	168.35	981.58
dsr	12.48	12.48	12.48	12.48	13.71	13.71	25.24	25.24	19.32	19.32
e	821.65	0.00	821.65	0.00	821.65	0.00	883.40	223.29	834.60	14.32
z	2.34	2.13	2.76	2.17	3.55	3.34	27.27	21.22	21.01	13.96

Table 5.3.29-12: Calculation of A boundary (Hom) (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000
$\Delta_{dif(S,R)}$	17.39	20.26	23.21	26.19	29.18	32.18	35.19	38.20
$A_{ground,(S,O)}$	-1.23	-1.65	-2.40	-2.40	-2.40	-2.40	-2.40	-2.40
$A_{ground,(O,R)}$	-1.50	-1.50	-1.50	-1.50	-1.50	-1.50	-1.50	-1.50
$\Delta_{dif(S',R)}$	18.08	20.96	23.92	26.91	29.90	32.91	35.91	38.92
$\Delta_{dif(S,R')}$	19.13	22.03	25.00	27.99	30.99	34.00	37.00	40.01
$\Delta_{ground(S,O)}$	-1.14	-1.53	-2.24	-2.24	-2.23	-2.23	-2.23	-2.23
$\Delta_{ground(O,R)}$	-1.25	-1.24	-1.24	-1.24	-1.24	-1.24	-1.24	-1.24
A_{dif}	15.01	17.49	19.73	21.53	21.53	21.53	21.53	21.53
$A_{ground(S,R)}$	-	-	-	-	-	-	-	-
$A_{boundary,H}$	**15.01**	**17.49**	**19.73**	**21.53**	**21.53**	**21.53**	**21.53**	**21.53**

Table 5.3.29-13: Calculation of A boundary (Fav) (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000
$\Delta_{dif(S,R)}$	12.74	15.36	18.17	21.08	24.04	27.03	30.02	33.03
$A_{ground,(S,O)}$	-4.03	-4.03	-4.03	-4.03	-4.03	-4.03	-4.03	-4.03
$A_{ground,(O,R)}$	-1.50	-1.50	-1.50	-1.50	-1.50	-1.50	-1.50	-1.50
$\Delta_{dif(S',R)}$	12.80	15.43	18.25	21.16	24.12	27.10	30.10	33.10
$\Delta_{dif(S,R')}$	14.44	17.18	20.06	23.00	25.98	28.98	31.98	34.98
$\Delta_{ground(S,O)}$	-4.01	-4.01	-4.01	-4.01	-4.01	-4.01	-4.01	-4.01
$\Delta_{ground(O,R)}$	-1.25	-1.24	-1.23	-1.22	-1.22	-1.22	-1.22	-1.22
A_{dif}	7.48	10.11	12.94	15.86	18.82	19.78	19.78	19.78
$A_{ground(S,R)}$	-	-	-	-	-	-	-	-
$A_{boundary,H}$	**7.48**	**10.11**	**12.94**	**15.86**	**18.82**	**19.78**	**19.78**	**19.78**

Table 5.3.29-14: Spectral intermediate and final results for the vertical propagation plane (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	
L_W in dB	120	120	120	120	120	120	120	120	
α_{atm}	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.12	0.41	1.04	1.93	3.66	9.68	32.81	117.03	
A_{div} in dB	71.01	71.01	71.01	71.01	71.01	71.01	71.01	71.01	
$A_{boundary,H}$ in dB	15.01	17.49	19.73	21.53	21.53	21.53	21.53	21.53	
$A_{boundary,F}$ in dB	7.48	10.11	12.94	15.86	18.82	19.78	19.78	19.78	**Total**
L_H in dB	33.86	31.09	28.21	25.53	23.80	17.78	-5.35	-89.57	37.02
L_F in dB	41.39	38.46	35.00	31.20	26.51	19.54	-3.60	-87.82	44.12
L in dB	39.09	36.18	32.82	29.23	25.36	18.75	-4.39	-88.60	41.88
A-weighting dB	-26.2	-16.1	-8.6	-3.2	0.0	1.2	1.0	-1.1	
$L_A{}^a$ in dB	**12.89**	**20.08**	**24.22**	**26.03**	**25.36**	**19.95**	**-3.39**	**-89.70**	**30.90**

Table 5.3.29-15: Ground attenuation for lateral propagation (Source: Umweltbundesamt [9])

Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000
Lateral right								
w hom	0.00	0.00	0.00	0.01	0.08	0.41	2.10	10.13
Cf hom	1128.04	1197.32	730.42	131.57	13.31	2.44	0.47	0.10
A ground-right hom	**-1.50**	**-1.50**	**-0.70**	**15.46**	**20.97**	**12.75**	**5.42**	**-1.02**
w fav	0.00	0.00	0.00	0.01	0.07	0.36	1.85	9.02
Cf fav	1111.94	1195.92	789.97	159.33	15.54	2.78	0.54	0.11
A ground-right fav	**-4.36**	**-4.36**	**-4.36**	**-4.36**	**-4.36**	**-4.36**	**-4.36**	**-4.36**
Lateral left								
w hom	0.00	0.00	0.00	0.01	0.07	0.39	2.01	9.71
Cf hom	1117.41	1192.77	751.23	141.43	14.08	2.56	0.50	0.10
A ground- left hom	**-1.53**	**-1.53**	**-1.25**	**15.70**	**21.95**	**13.29**	**5.98**	**-0.45**
w fav	0.00	0.00	0.00	0.01	0.06	0.33	1.73	8.47
Cf fav	1099.02	1188.76	818.95	176.08	16.94	2.99	0.58	0.12
A ground- left Fav	**-4.53**	**-4.53**	**-4.53**	**-4.53**	**-4.53**	**-4.53**	**-4.53**	**-4.53**

Table 5.3.29-16: Calculation of the unweighted partial level for the right detour (Hom) (Source: Umweltbundesamt [9])

Lateral right H									
Frequency (Hz)-->	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	
L_W in dB	120	120	120	120	120	120	120	120	
α-atm(10°,70%)	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.13	0.42	1.07	1.98	3.76	9.94	33.70	120.22	
A_{div} in dB	71.01	71.01	71.01	71.01	71.01	71.01	71.01	71.01	
$A_{ground,H}$ in dB	-1.50	-1.50	-0.70	15.46	20.97	12.75	5.42	-1.02	
$\Delta_{dif,H}$ in dB	27.84	30.81	33.82	36.83	39.83	42.84	45.85	48.86	
A_H in dB	97.48	100.74	105.20	125.28	135.57	136.55	155.99	239.08	**Total**
L_H in dB	**22.52**	**19.26**	**14.80**	**-5.28**	**-15.57**	**-16.55**	**-35.99**	**-119.08**	**24.68**

Table 5.3.29-17: Calculation of the unweighted partial level for the right detour (Fav) (Source: Umweltbundesamt [9])

Lateral right F									
Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	
L_W in dB	120	120	120	120	120	120	120	120	
α-atm(10°,70%)	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.12	0.42	1.07	1.97	3.74	9.88	33.51	119.51	
A_{div} in dB	71.01	71.01	71.01	71.01	71.01	71.01	71.01	71.01	
$A_{ground,F}$ in dB	-4.36	-4.36	-4.36	-4.36	-4.36	-4.36	-4.36	-4.36	
$\Delta_{dif,F}$ in dB	26.64	29.69	32.72	35.73	38.74	41.75	44.76	47.77	
A_F in dB	93.42	96.76	100.44	104.35	109.13	118.28	144.92	233.93	**Total**
L_F in dB	**26.58**	**23.24**	**19.56**	**15.65**	**10.87**	**1.72**	**-24.92**	**-113.93**	**29.07**

Table 5.3.29-18: Calculation of the unweighted partial level for the left detour (Hom) (Source: Umweltbundesamt [9])

Lateral left H									
Frequency (Hz)-->	63	125	250	500	1000	2000	4000	8000	
L_W in dB	120	120	120	120	120	120	120	120	
α-atm(10°,70%)	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.12	0.42	1.07	1.97	3.74	9.88	33.50	119.48	
A_{div} in dB	71.01	71.01	71.01	71.01	71.01	71.01	71.01	71.01	
$A_{ground,H}$ in dB	-1.53	-1.53	-1.25	15.70	21.95	13.29	5.98	-0.45	
$\Delta_{dif,H}$ in dB	26.71	29.68	32.69	35.69	38.70	41.71	44.72	47.73	
A_H in dB	96.32	99.58	103.51	124.37	135.40	135.89	155.21	237.78	**Total**
L_H in dB	**23.68**	**20.42**	**16.49**	**-4.37**	**-15.40**	**-15.89**	**-35.21**	**-117.78**	**25.89**

Table 5.3.29-19: Calculation of the unweighted partial level for the left detour (Fav) (Source: Umweltbundesamt [9])

Lateral left F									
Frequency (Hz)-->	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	
L_W in dB	120	120	120	120	120	120	120	120	
α-atm(10°,70%)	0.12	0.41	1.04	1.93	3.66	9.66	32.77	116.88	
A_{atm} in dB	0.12	0.42	1.06	1.96	3.71	9.81	33.27	118.66	
A_{div} in dB	71.01	71.01	71.01	71.01	71.01	71.01	71.01	71.01	
$A_{ground,F}$ in dB	-4.53	-4.53	-4.53	-4.53	-4.53	-4.53	-4.53	-4.53	
$\Delta_{dif,F}$ in dB	20.94	25.04	29.56	33.48	36.81	39.91	42.94	45.95	
A_F in dB	87.54	91.93	97.10	101.92	107.00	116.20	142.69	231.09	**Total**
L_F in dB	**32.46**	**28.07**	**22.90**	**18.08**	**13.00**	**3.80**	**-22.69**	**-111.09**	**34.29**

Table 5.3.29-20: Partial and total levels for the three propagation paths (Source: Umweltbundesamt [9])

Frequency (Hz)-->	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	
L_A in dB top	12.89	20.08	24.22	26.03	25.36	19.95	-3.39	-89.70	
L_A in dB right	-1.19	5.59	9.20	9.47	7.87	-0.03	-26.60	-116.88	
L_A in dB left	3.79	9.64	12.19	11.90	9.99	2.04	-24.46	-114.36	**Total**
L_A in dB	**13.54**	**20.60**	**24.61**	**26.29**	**25.56**	**20.06**	**-3.33**	**-89.68**	**31.19**

6 Test scenarios for BUF, calculation method aircraft noise

6.1 Summary

The calculation of the sound propagation of aircraft noise is carried out in accordance with [3] and [6].

Using the example of a fictitious airport (local, level), individual scenarios and an overall scenario for the exposure level and the assessment levels LDEN and LN of the Environmental Noise Directive are used to check whether the mathematical implementation of the calculation method is carried out with a precision of at least ± 0.5 dB.

6.2 Introduction

6.2.1 Purpose of the testing

The test airport described below was designed with corresponding "reference cases" (see chapter 6.2.2). Conceptually, the test airport is based on a proposal from ECAC.CEAC Doc 29 (4th Edition) Volume 3, Part 1 - Reference Cases and Verification Framework.

It is deliberately a fictitious airport, since the purpose of precision testing is to check as many defined processes and calculation steps as possible. This includes in particular the formation of the flight path segments for the take-off run, the initial climb and the landing. The result of the investigation depends on the compliance with a certain sequence of procedural steps.

6.2.2 Reference cases

The reference cases (CASE_ID) represent a comprehensive and proven set of input data that can be used to check and compare the results of calculations of software implementations from different vendors or developers. In contrast to the test airport of ECAC.CEAC Doc 29 (4th Edition), the present reference cases are based on actual aircraft of which the parameters serve as a fixed reference in the ANP database.

The reference cases include combinations of three real reference aircraft on curved and rectilinear routes, for approach and departure operations and the following of the airfield traffic pattern. A total of 15 reference cases are created from the combinations of route and aircraft and their results are made available for comparison.

To facilitate identification, the designations of the reference cases are composed of the combination of aircraft type (ICAO ATD) and routes. The designations are presented in the following sections.

The three real aircraft types are

- Jet propulsion aircraft with turbofan engines at the tail (ICAO ATD: CRJ9)
- Jet propulsion aircraft with turbofan engines at the wings (ICAO ATD: A320)
- Propeller aircraft (ICAO ATD: DH8C)

Make sure that the ICAO ATD is connected to the NPD_ID via the ACFT_ID.

The test airport of ECAC.CEAC Doc 29 (4th Edition) uses only the NPD_ID for its hypothetical aircraft.

6.2.3 Airport

The reference cases are based on a hypothetical airport from which the aircraft take off and land. The airport is described according to Appendix A from [3] (see chapter 6.4). It is a one-way system with a strict west/east orientation. The airport reference point is the zero point of the local coordinate system. The runway reference point is located in the middle of the runway.

A level terrain is assumed (without using a digital terrain model (DTM)).

6.2.4 Air routes

Five reference distances (see chapter 6.6) are defined in the form of straight lines and curves, all of which - except for the air traffic pattern - are oriented in the eastern direction of movement. There is a curved route and straight routes (represented by codes "C" for "curved" and "S" for "straight") for both approach and departure operations (represented by codes "A" for "arrival" and "D" for "departure"). The air traffic pattern has two 180 degree curves (represented by the code "CI"). The convention of the descriptive direction must be observed.

In order not to complicate the calculations unnecessarily, a corridor extension was dispensed with.

The five routes are therefore identified by the following designations: "AC" and "AS" for curved and straight arrival routes or "DC" and "DS" for curved and straight departure routes and "CI" for the air traffic pattern.

There are a total of 15 reference cases. Each reference case has a unique "CASE_ID" based on the aircraft and route designation introduced in the previous paragraph. For example, "CASE_ID" is "A320 DS" for the example in Chapter 6.13.

6.2.5 Aircraft data

For each aircraft used, the relevant input data are provided in 3 tables (see Chapters 6.7, 6.8, 6.9).

The first table serves the basic classification or assignment of the aircraft in the context of Annex I from [3]. Starting from ICAO_ATD, which represents an aircraft class, the assignment must be made to a specific version of the aircraft type (ACFT_ID) to ensure uniqueness. For example, the properties of the A320-232 (ACFT_ID) and not the A320-211 (ACFT_ID) are adopted for the A320 (ICAO_ATD) used.

Exactly one engine type (NPD_ID) is assigned to each specific version of the aircraft type (ACFT_ID). However, this engine type may appear at different ACFT_IDs. The A320-232 (ACFT_ID) is equipped with the engine type V2527A (NPD_ID). The acoustic data for the respective engine type are taken from Appendices I from [3] in the third table. For the further calculation it is of importance whether the assignment of the level to the power parameters of the engine is given in Newton (jet) or in percent of the maximum thrust (propeller).

The specification of the spectral number is informative, in contrast to the specification of the lateral directivity ID, which is included in the calculation.

The second table describes the flight profiles of the respective ACFT_ID that must be used for flight path segmentation. The flight profiles used are standardized fixed-point profiles taken from Tables I-5 and I-6 from [3] for the real aircraft. Procedural profiles are not subject to testing.

Since only the exposure levels and the two assessment levels of the Environmental Noise Directive are checked in the reference cases and not the maximum level, the third table only lists the exposure level ("SEL") in its spectral distribution as a function of the shear setting as an "assessment parameters".

6.2.6 Points of immission

Reference results are provided for all reference cases. For this purpose, 20 immission points are defined and listed with their x, y and z coordinates in chapter 6.10. The immission points lie on the ground and have the height z = 0 m. They are referred to as IP01 to IP20.

Not all immission points are relevant for all reference cases. Among other things, no combination of reference cases and immission points were used where the individual contributions are far below the highest individual contribution. For Route AS and IP 16, for example, the distance between the flight lane and IP16 meant that it was not necessary to determine the level for Route AS as well, at least for the individual scenarios. Of course, this is especially true for the DC and DS routes.

The results at the different immission points are sensitive to different elements of the calculation. For example, the IP06 - IP11 immission points of aircraft in fly over are affected, so that the levels can agree with the reference results, even if there are errors in the calculation of the take-off roll distance and its segmentation. However, the IP02 - IP05 immission points are located close to the runway and therefore require that the calculation of the immission contributions through the runway be implemented correctly to match the reference results. The IP20 immission point has a special position in that it is only intended for checking the horizontal flight part in the air traffic pattern (see chapter 6.10).

Figure 6.2.8-1 shows the flight routes as well as the location of the twenty immission points.

6.2.7 Reference results

All relevant combinations of reference cases and immission points and individual scenarios to be calculated with them are listed in chapter 6.11. In addition, there is an overall scenario in which all routes with all aircraft types must be calculated for all 20 IP.

The reference results shall allow a relatively fast and efficient verification of the development model results against the reference results.

The calculation of the overall scenario is a relatively fast and simple modeling scenario. These results therefore provide a measure by which developers can verify the performance of a new model. Such a comparison will highlight where there are differences between the total expenditure of a development model and the reference results.

The parameters to be calculated for the test airport are the exposure level (LpAE) and the two assessment parameters of the Environmental Noise Directive (LDEN and LN). Grid calculations and isolines derived from them are not the subject of the test.

All reference levels are listed in chapter 6.12.

For each single point calculation, additional intermediate results (see chapter 6.13) must be generated. For readability these should be the geometry of the flight path segments, the acoustic partial results and the input parameters for the determination of the acoustic correction values.

The reference segment results include the results for the main calculation parameters for each segment of the trajectories of the fifteen reference cases. These parameters include:

- • Profile geometry
- • The distance and thrust to interpolate NPD curves
- • The NPD sound exposure level ("baseline_SEL")
- • Distances and angles for calculating the level adjustments
- • The level adjustments
- • The segment exposure level

The reference segment results provide the results for the main parameters at each step of the calculation. Developers can use these results to diagnose any discrepancies between the results of a development model and the reference results.

The comparison of the levels for the different immission points can therefore help developers identify areas in which their development model deviates from the methodology [3]. Once these areas are known, a focused diagnosis can be performed using the reference segment results.

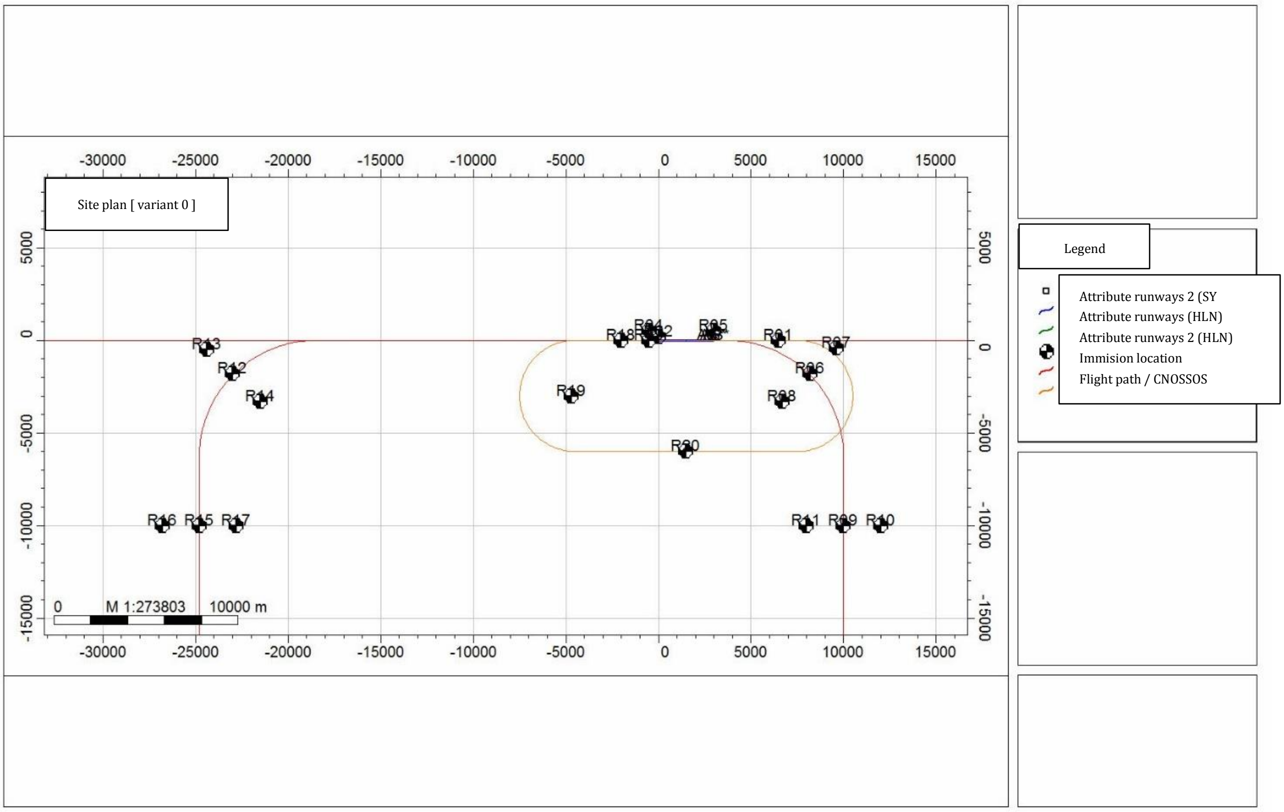
6.2.8 Quality goals

A data acquisition system based on the QSI format in accordance with DIN 45687 is provided for the verification procedure (see also Chapters 6.3 to 6.6).

The geometry (trajectory segments) shall not deviate by more than ± 1 m.

The maximum deviation from the reference levels is ± 0.5 dB. A maximum level deviation of ± 0.1 dB shall be aimed at.

Figure 6.2.8-1: Route plot with immission points (Source: Umweltbundesamt [10])



6.3 Data sheets for airports, general information

6.3.1 Date of DES creation

2017-02-28

6.3.2 Current year

2016

6.4 Data sheets for airports, airport data

6.4.1 Airport

Name	Test airport
ICAO-airport code	EDXX

6.4.2 Airport reference point

Latitude and longitude (WGS84)	N E
UTM32/33 (ETRS89)	R: 0,00 m / H: 0,00 m

6.4.3 Airport altitude above sea level [m]

0.00

6.4.4 Runways (Source: Umweltbundesamt [10])

		I	II	III	IV
1.	Designation	09 / 27	/	/	/
2.	Available/planned for year	Available			
3.	Indicative direction [°] Geographical North (WGS84) Grid North UTM32/33 (ETRS89)	90,0/270,0 / /	 / /	 / /	 / /
4.	Total length [m]	3000			
5.	Coordinates of the path reference point Geographical coordinates (WGS84) UTM coordinates 32/33 (ETRS89)	N E R:/ H:	N E	N E	N E
6.	Right and high value difference of the runway reference point from the airport reference point [m].	Δ R = 1.500,00 Δ H = 0,00	Δ R = Δ H =	ΔR = ΔH =	Δ R = Δ H =
7.	Distance of the starting point from the path reference point [m].	-1500/-1500	/	/	/
8.	Distance of the landing threshold from the runway reference point [m].	1500/1500	/	/	/
9.	Distance from the beginning of the path to the path reference point [m].	-1500/-1500	/	/	/
10.	Meridian convergence	0.0			

6.5 Data sheets for airports, flight details

6.5.1 Total number of aircraft movements in the 12 months of the current year

Aircraft group	Daytime (06:00 to 18:00)	Evening (18:00 bis 22:00)	Nighttime (22:00 to 06:00)	Total
A320	18,500	8,500	25,000	52,000
CRJ9	28,800	12,200	22,000	63,000
DH8C	51,200	20,800	23,000	95,000
Total	98,500	41,500	70,000	210,000

(Source: Umweltbundesamt [10])

6.6 Data sheets for airports, aerial flight operations

6.6.1 Air routes

6.6.1.1 Route description

6.6.1.1.1 Designation

DC

6.6.1.1.2 Runway

09/27

6.6.1.1.3 Direction of take-off

09

6.6.1.1.4 Description of the departure route (in flight direction) (Source: Umweltbundesamt [10])

1	2	3	4	5	6	7
Section	Straight	Curve			Corridor width	
No.	length [m]	L/R	Change of direction [°]	Radius [m]	Start | End of the section [m]	
1	2,200				0	0
2		R	90	6,300	0	0

6.6.1.2 Aircraft movement data

6.6.1.2.1 Designation

DC

6.6.1.2.2 Runway

09/27

6.6.1.2.3 Direction of take-off

09

6.6.1.2.4 Aircraft movement figures (Source: Umweltbundesamt [10])

Aircraft type	Daytime (06:00 to 18:00)	Evening (18:00 bis 22:00)	Nighttime (22:00 to 06:00)	Total
A320-S	3,750	1,250	7,500	12,500
CRJ9-S	7,500	2,500	5,000	15,000
DH8C-S	15,000	5,000	2,500	22,500
Total	26,250	8,750	15,000	50,000

6.6.2 Aircraft departure routes

6.6.2.1 Route description

6.6.2.1.1 Designation

DS

6.6.2.1.2 Runway

09/ 27s

6.6.2.1.3 Direction of take-off

09

6.6.2.1.4 Description of the departure route (in flight direction) (Source: Umweltbundesamt [10])

1	2	3	4	5	6	7
Section No.	Straight	Curve			Corridor width	
	length [m]	L/R	Change of direction [°]	Radius [m]	Start | End of the section [m]	
1	100,000				0	0

6.6.2.2 Aircraft movement data

6.6.2.2.1 Designation

DS

6.6.2.2.2 Runway

09/ 27s

6.6.2.2.3 Direction of take-off

09

6.6.2.2.4 Aircraft movement figures (Source: Umweltbundesamt [10])

Aircraft type	Daytime (06:00 to 18:00)	Evening (18:00 bis 22:00)	Nighttime (22:00 to 06:00)	Total
A320-S	3,750	1,250	7,500	12,500
CRJ9-S	7,500	2,500	5,000	15,000
DH8C-S	15,000	5,000	2,500	22,500
Total	26,250	8,750	15,000	50,000

6.6.3 Aircraft approach routes

6.6.3.1 Route description

6.6.3.1.1 Designation: AC

6.6.3.1.2 Runway: 09/27

6.6.3.1.3 Landing direction: 09

6.6.3.1.4 Gliding angle [°]: 3.0

6.6.3.1.5 Description of the approach route (against the flight direction) (Source: Umweltbundesamt [10])

1	2	3	4	5	6	7
Section	Straight	Curve			Corridor width	
No.	length [m]	L/R	Change of direction [°]	Radius [m]	Start | End of the section [m]	
1	20,000				0	0
2		L	90	6,300	0	0

6.6.3.2 Aircraft movement data

6.6.3.2.1 Designation

AC

6.6.3.2.2 Runway

09/27

6.6.3.2.3 Landing direction

09

6.6.3.2.4 Aircraft movement figures (Source: Umweltbundesamt [10])

Aircraft type	Daytime (06:00 to 18:00)	Evening (18:00 bis 22:00)	Nighttime (22:00 to 06:00)	Total
A320-L	4,500	3,000	5,000	12,500
CRJ9-L	5,400	3,600	6,000	15,000
DH8C-L	8,100	5,400	9,000	22,500
Total	18,000	12,000	20,000	50,000

6.6.4 Aircraft approach routes

6.6.4.1 Route description

6.6.4.1.1 Designation	AS
6.6.4.1.2 Runway	09/27
6.6.4.1.3 Landing direction	09
6.6.4.1.4 Gliding angle [º]	3.0

6.6.4.1.5 Description of the approach route (against the flight direction) (Source: Umweltbundesamt [10])

1	2	3	4	5	6	7
Section	Straight	Curve			Corridor width	
No.	length [m]	L/R	Change of direction [º]	Radius [m]	Start | End of the section [m]	
1	100,000				0	0

6.6.4.2 Aircraft movement data

6.6.4.2.1 Designation

AS

6.6.4.2.2 Runway

09/27

6.6.4.2.3 Landing direction

09

6.6.4.2.4 Aircraft movement figures (Source: Umweltbundesamt [10])

Aircraft type	Daytime (06:00 to 18:00)	Evening (18:00 bis 22:00)	Nighttime (22:00 to 06:00)	Total
A320-L	4,500	3,000	5,000	12,500
CRJ9-L	5,400	3,600	6,000	15,000
DH8C-L	8,100	5,400	9,000	22,500
Total	18,000	12,000	20,000	50,000

6.6.5 Air traffic patterns

6.6.5.1 Route description

6.6.5.1.1 Designation: CI

6.6.5.1.2 Runway: 09/27

6.6.5.1.3 Direction of take-off: 27

6.6.5.1.4 Gliding angle [°]: 3.0

6.6.5.1.5 Description of the air traffic pattern (against the flight direction) (Source: Umweltbundesamt [10])

1	2	3	4	5	6	7
Section	Straight	Curve			Corridor width	
No.	length [m]	L/R	Change of direction [°]	Radius [m]	Start | End of the section [m]	
1	6000.00				0	0
2		R	180	3000	0	0
3	12000.00				0	0
4		R	180	3000	0	0

6.6.5.1.6 Altitude above airport in opposite approach [m]: 914.40

6.6.5.2 Aircraft movement data

6.6.5.2.1 Designation

CI

6.6.5.2.2 Runway

09/27

6.6.5.2.3 Aircraft movement figures (Source: Umweltbundesamt [10])

Aircraft group	Daytime (06:00 to 18:00)	Evening (18:00 bis 22:00)	Nighttime (22:00 to 06:00)	Total
A320	2,000			2,000
CRJ9	3,000			3,000
DH8C	5,000			5,000
Total	10,000			10,000

6.7 Data of aircraft types, aircraft group A320

6.7.1 Data sheet A320-S

Table 6.7.1-1: Data sheet A320-S, a) (Source: Umweltbundesamt [10])

ACFT_ID	NPD_ID	performance parameters	Spectral number departure (Departure Spectral Class ID)	Identif. of the lateral directivity (Lateral Directivity ID)
A320-232	V2527A	CNT (lb)	103	Wings

Table 6.7.1-2: Data sheet A320-S, b) (Source: Umweltbundesamt [10])

ACFT_ID	Procedure	Section length	Step	Distance [m]	Height [m]	TAS [m/s]	Propulsion [N per engine]
A320-232	S	1	1	0.00	0.00	0.00	110076.05
A320-232	S	1	2	1812.25	0.00	83.69	91647.07
A320-232	S	1	3	3684.54	304.80	84.93	93041.18
A320-232	S	1	4	5921.41	413.31	109.72	88301.13
A320-232	S	1	5	6829.78	455.80	118.05	86754.18
A320-232	S	1	6	7134.58	487.56	118.26	67774.02
A320-232	S	1	7	11232.95	914.40	120.73	70274.67
A320-232	S	1	8	13431.99	992.76	133.74	70245.53
A320-232	S	1	9	20364.82	1676.40	138.32	73361.45
A320-232	S	1	10	26970.56	2286.00	142.59	75596.80
A320-232	S	1	11	35998.65	3048.00	148.25	77670.82

Table 6.7.1-3: Data sheet A320-S, c) (Source: Umweltbundesamt [10])

NPD_ID	Procedure	Assessment parameters	Propulsion setup	L_200ft	L_400ft	L_630ft	L_1000ft	L_2000ft	L_4000ft	L_6300ft	L_10000ft	L_16000ft	L_25000ft
V2527A	S	LAmax	10000.0	94.8	86.3	80.5	74.8	66.5	57.6	51.1	44.0	36.2	28.2
V2527A	S	LAmax	14000.0	96.7	88.6	83.5	78.4	70.5	61.7	55.3	48.1	40.1	31.8
V2527A	S	LAmax	19000.0	101.2	93.9	89.0	84.0	76.1	67.3	61.1	54.1	46.3	38.2
V2527A	S	LAmax	23000.0	104.0	96.9	92.2	87.3	79.4	70.8	64.7	57.9	50.3	42.0
V2527A	S	SEL	10000.0	95.0	90.2	86.8	83.5	78.1	71.8	67.2	61.9	55.9	49.4
V2527A	S	SEL	14000.0	98.3	93.9	90.9	87.6	82.1	75.8	71.1	65.6	59.4	52.8
V2527A	S	SEL	19000.0	102.5	98.4	95.5	92.3	87.2	81.1	76.7	71.5	65.7	59.4
V2527A	S	SEL	23000.0	104.6	100.7	98.0	95.0	90.0	84.3	80.0	75.1	69.5	63.3

6.7.2 Data sheet A320-L

Table 6.7.2-1: Data sheet A320-L, a) (Source: Umweltbundesamt [10])

ACFT_ID	NPD_ID	Performance parameters	Spectral number departure (Approach Spectral Class ID)	Identif. of the lateral directivity (Lateral Directivity ID)
A320-232	V2527A	CNT (lb)	205	Wings

Table 6.7.2-2: Data sheet A320-L, b) (Source: Umweltbundesamt [10])

ACFT_ID	Procedure	Section length	Step	Distance [m]	Height [m]	TAS [m/s]	Propulsion [N per engine]
A320-232	L	1	1	-1248.05	0.00	15.28	11787.73
A320-232	L	1	2	-394.79	0.00	66.72	70726.38
A320-232	L	1	3	-300.00	0.00	68.26	19545.26
A320-232	L	1	4	10279.18	554.43	70.06	20881.59
A320-232	L	1	5	11423.28	614.39	73.76	14576.08
A320-232	L	1	6	11728.08	630.36	74.69	4.45
A320-232	L	1	7	15048.94	804.40	91.56	4.45
A320-232	L	1	8	22963.71	1219.20	99.28	4.45
A320-232	L	1	9	24349.54	1219.20	107.51	4.45
A320-232	L	1	10	30031.99	1219.20	133.95	4.45
A320-232	L	1	11	30336.79	1219.20	135.24	18314.71
A320-232	L	1	12	60816.79	1219.20	135.24	18314.71

Table 6.7.2-3: Data sheet A320-L, c) (Source: Umweltbundesamt [10])

NPD_ID	Procedure	Assessment parameters	Propulsion setup	L_200ft	L_400ft	L_630ft	L_1000ft	L_2000ft	L_4000ft	L_6300ft	L_10000ft	L_16000ft	L_25000ft
V2527A	L	LAmax	2000.0	89.3	82.8	78.2	73.4	65.8	57.4	51.2	44.4	36.7	28.6
V2527A	L	LAmax	2700.0	89.5	83.0	78.3	73.5	65.8	57.4	51.3	44.4	36.7	28.6
V2527A	L	LAmax	6000.0	91.6	84.7	79.5	74.2	66.5	58.0	51.9	45.0	37.2	29.1
V2527A	L	SEL	2000.0	93.1	89.1	86.1	82.9	77.7	71.7	67.1	61.9	55.8	49.2
V2527A	L	SEL	2700.0	93.3	89.2	86.2	83.0	77.7	71.8	67.2	62.0	55.8	49.3
V2527A	L	SEL	6000.0	94.7	90.5	87.4	83.9	78.5	72.3	67.7	62.5	56.3	49.7

6.8 Data of aircraft types, aircraft group CRJ9

6.8.1 Data sheet CRJ9-S

Table 6.8.1-1: Data sheet CRJ9-S, a) (Source: Umweltbundesamt [10])

ACFT_ID	NPD_ID	Performance parameters	Spectral number departure (Departure Spectral Class ID)	Identif. of the lateral directivity (Lateral Directivity ID)
CRJ9-ER	CF348C5	CNT (lb)	113	Fuselage

Table 6.8.1-2: Data sheet CRJ9-S, b) (Source: Umweltbundesamt [10])

ACFT_ID	Procedure	Section length	Step	Distance [m]	Height [m]	TAS [m/s]	Propulsion [N per engine]
CRJ9-ER	S	1	1	0.00	0.00	0.00	58913.65
CRJ9-ER	S	1	2	1906.04	0.00	86.42	46377.69
CRJ9-ER	S	1	3	2851.71	141.73	87.04	46788.17
CRJ9-ER	S	1	4	3822.62	304.80	87.71	47243.80
CRJ9-ER	S	1	5	4957.18	334.82	105.71	44776.16
CRJ9-ER	S	1	6	5261.98	371.89	105.91	38409.81
CRJ9-ER	S	1	7	9723.70	914.40	108.74	39762.37
CRJ9-ER	S	1	8	12636.83	976.49	133.64	37933.80
CRJ9-ER	S	1	9	33652.18	3048.00	148.25	42685.64

Table 6.8.1-3: Data sheet CRJ9-S, c) (Source: Umweltbundesamt [10])

NPD_ID	Procedure	Assessment parameters	Propulsion setup	L_200ft	L_400ft	L_630ft	L_1000ft	L_2000ft	L_4000ft	L_6300ft	L_10000ft	L_16000ft	L_25000ft
CF348C5	S	LAmax	7250.0	94.5	87.9	83.5	78.7	71.0	62.3	56.0	48.8	40.5	31.7
CF348C5	S	LAmax	16250.0	103.6	97.1	92.6	87.9	80.2	71.6	65.3	58.3	50.3	42.0
CF348C5	S	SEL	7250.0	96.4	92.3	89.5	86.5	81.5	75.3	70.4	64.7	58.0	50.6
CF348C5	S	SEL	16250.0	104.7	100.9	98.2	95.3	90.4	84.4	79.6	74.0	67.6	60.7

6.8.2 Data sheet CRJ9-L

Table 6.8.2-1: Data sheet CRJ9-L, a) (Source: Umweltbundesamt [10])

ACFT_ID	NPD_ID	Performance parameters	Spectral number departure (Approach Spectral Class ID)	Identif. of the lateral directivity (Lateral Directivity ID)
CRJ9-ER	CF348C5	CNT (lb)	216	Fuselage

Table 6.8.2-2: Data sheet CRJ9-L, b) (Source: Umweltbundesamt [10])

ACFT_ID	Procedure	Section length	Step	Distance [m]	Height [m]	TAS [m/s]	Propulsion [N per engine]
CRJ9-ER	L	1	1	-1197.33	0.00	15.28	6016.19
CRJ9-ER	L	1	2	-426.80	0.00	71.40	6016.19
CRJ9-ER	L	1	3	-300.00	0.00	80.19	15831.59
CRJ9-ER	L	1	4	11331.87	609.60	73.51	16967.21
CRJ9-ER	L	1	5	22658.91	1203.23	75.67	18266.71
CRJ9-ER	L	1	6	22963.71	1219.20	75.72	18473.37
CRJ9-ER	L	1	7	24182.91	1219.20	75.72	18473.37
CRJ9-ER	L	1	8	24487.71	1219.20	75.72	4.45
CRJ9-ER	L	1	9	30170.15	1219.20	132.87	4.45
CRJ9-ER	L	1	10	30474.95	1219.20	135.24	12397.62
CRJ9-ER	L	1	11	60954.95	1219.20	135.24	12397.62

Table 6.8.2-3: Data sheet CRJ9-L, c) (Source: Umweltbundesamt [10])

NPD_ID	Procedure	Assessment para-meters	Propulsion setup	L_200ft	L_400ft	L_630ft	L_1000ft	L_2000ft	L_4000ft	L_6300ft	L_10000ft	L_16000ft	L_25000ft
CF348C5	L	LAmax	2500.0	89.7	83.1	78.6	73.8	66.2	57.6	51.3	44.1	36.0	27.3
CF348C5	L	LAmax	7250.0	91.3	84.7	80.2	75.4	67.6	58.9	52.6	45.5	37.6	29.2
CF348C5	L	SEL	2500.0	93.1	89.2	86.4	83.3	78.2	72.0	67.1	61.5	54.9	47.7
CF348C5	L	SEL	7250.0	95.2	91.0	88.1	85.0	79.8	73.6	68.8	63.2	56.8	49.9

6.9 Data of aircraft types, aircraft group DH8C

6.9.1 Data sheet DH8C-S

Table 6.9.1-1: Data sheet DH8C-S, a) (Source: Umweltbundesamt [10])

ACFT_ID	NPD_ID	performance parameters	Spectral number departure (Departure Spectral Class ID)	Identif. of the lateral directivity (Lateral Directivity ID)
DHC830	PW120	CNT (% of max. stat. propulsion)	112	Prop.

Table 6.9.1-2: Data sheet DH8C-S, b) (Source: Umweltbundesamt [10])

ACFT_ID	Procedure	Section length	Step	Distance [m]	Height [m]	TAS [m/s]	Propulsion [% per engine]
DHC830	S	1	1	0.00	0.00	0.00	150.90
DHC830	S	1	2	842.86	0.00	57.25	95.13
DHC830	S	1	3	2803.25	304.80	58.08	97.17
DHC830	S	1	4	3490.36	377.01	63.32	92.80
DHC830	S	1	5	3795.16	398.83	65.69	83.52
DHC830	S	1	6	4579.22	454.91	71.40	77.29
DHC830	S	1	7	8720.27	914.40	72.99	80.05
DHC830	S	1	8	14789.44	1263.06	97.02	63.37
DHC830	S	1	9	20961.13	1676.40	99.02	65.86
DHC830	S	1	10	30370.36	2286.00	102.11	69.54
DHC830	S	1	11	42792.30	3048.00	106.12	74.13

Table 6.9.1-3: Data sheet DH8C-S, c) (Source: Umweltbundesamt [10])

NPD_ID	Procedure	Assessment parameters	Propulsion setup	L_200ft	L_400ft	L_630ft	L_1000ft	L_2000ft	L_4000ft	L_6300ft	L_10000ft	L_16000ft	L_25000ft
PW120	S	LAmax	90.0	82.8	76.9	72.9	68.7	62.8	56.3	51.8	47.3	42.3	37.6
PW120	S	LAmax	100.0	85.2	79.4	75.8	71.9	65.9	59.7	55.3	51.0	46.2	41.6
PW120	S	LAmax	150.0	90.2	84.4	80.8	76.9	70.9	64.7	60.3	56.0	51.2	46.6
PW120	S	SEL	90.0	84.6	81.0	78.5	75.9	72.3	68.1	65.2	62.2	58.8	55.6
PW120	S	SEL	100.0	87.0	83.5	81.4	79.1	75.4	71.5	68.7	65.9	62.7	59.6
PW120	S	SEL	150.0	92.0	88.5	86.4	84.1	80.4	76.5	73.7	70.9	67.7	64.6

6.9.2 Data sheet DH8C-L

Table 6.9.2-1: Data sheet DH8C-L, a) (Source: Umweltbundesamt [10])

ACFT_ID	NPD_ID	Performance parameters	Spectral number departure (Approach Spectral Class ID)	Identif. of the lateral directivity (Lateral Directivity ID)
DHC830	PW120	CNT (% of max. stat. propulsion)	213	Prop.

Table 6.9.2-2: Data sheet DH8C-L, b) (Source: Umweltbundesamt [10])

ACFT_ID	Procedure	Section length	Step	Distance [m]	Height [m]	TAS [m/s]	Propulsion [% per engine]
DHC830	L	1	1	-969.34	0.00	15.28	4.40
DHC830	L	1	2	-366.93	0.00	52.26	26.10
DHC830	L	1	3	-300.00	0.00	55.04	18.71
DHC830	L	1	4	5515.92	304.80	55.86	19.40
DHC830	L	1	5	8423.89	457.20	60.96	16.42
DHC830	L	1	6	22658.91	1203.23	69.08	9.85
DHC830	L	1	7	22963.71	1219.20	69.24	13.03
DHC830	L	1	8	28646.15	1219.20	95.63	13.03
DHC830	L	1	9	28950.95	1219.20	96.81	30.39
DHC830	L	1	10	44190.95	1219.20	96.81	30.39

Table 6.9.2-3: Data sheet DH8C-L, c) (Source: Umweltbundesamt [10])

NPD_ID	Procedure	Assessment para-meters	Propulsion setup	L_200ft	L_400ft	L_630ft	L_1000ft	L_2000ft	L_4000ft	L_6300ft	L_10000ft	L_16000ft	L_25000ft
PW120	L	LAmax	35.0	87.1	80.3	75.5	70.5	62.4	54.0	48.9	43.8	39.1	34.8
PW120	L	LAmax	40.0	90.0	83.7	79.2	74.3	66.7	59.0	54.0	48.8	43.4	38.1
PW120	L	SEL	35.0	88.9	84.4	81.1	77.7	71.9	65.8	62.3	58.7	55.6	52.8
PW120	L	SEL	40.0	91.8	87.8	84.8	81.5	76.2	70.8	67.4	63.7	59.9	56.1

6.10 Coordinates of the immission points

6.10.1 Coordinates of the immission points

(Relative to airport reference point (ARP))

Table 6.10.1-1: Coordinates of the immission points (Source: Umweltbundesamt [10])

Designation of the immission point (IP)	Description	Relevant for	X [m]	Y [m]	Z [m]
IP01	Takeoff, 6.5 km from SOR	DC, DS	6500	0	0
IP02	SOR, to the side	AC, AS, DC, DS	0	200	0
IP03	SOR, behind	AC, AS, DC, DS	-500	0	0
IP04	SOR, behind and to the side	AC, AS, DC, DS	-500	500	0
IP05	Sideline, at runway end	AC, AS, DC, DS	3000	500	0
IP06	Departure curve, beneath	DC, CI	8200	-1800	0
IP07	Departure curve, outside	DC, CI	9600	-400	0
IP08	Departure curve, inside	DC, CI	6700	-3300	0
IP09	Departure curve end, beneath	DC	10000	-10000	0
IP10	Departure curve end, outside	DC	12000	-10000	0
IP11	Departure curve end, inside	DC	8000	-10000	0
IP12	Arrival curve, beneath	AC	-23000	-1800	0
IP13	Arrival curve, outside	AC, AS	-24400	-500	0
IP14	Arrival curve, inside	AC	-21500	-3300	0
IP15	Arrival curve end, beneath	AC	-24800	-10000	0
IP16	Arrival curve end, outside	AC	-26800	-10000	0
IP17	Arrival curve end, inside	AC	-22800	-10000	0
IP18	Approach, 2.0km from threshold	AC, AS	-2000	0	0
IP19	Ciruit center curve	CI	-4700	-3000	0
IP20	Circuit beneath level flight	CI	1500	-6000	0

6.11 Reference results, relevant scenarios

6.11.1 Individual scenarios

For the following combinations of route and immission point, immissions L_{pAE} must be calculated for each aircraft group in accordance with Chapters 6.7 to 6.9:

Route	Points of immission (IP)																			
	IP01	**IP02**	**IP03**	**IP04**	**IP05**	**IP06**	**IP07**	**IP08**	**IP09**	**IP10**	**IP11**	**IP12**	**IP13**	**IP14**	**IP15**	**IP16**	**IP17**	**IP18**	**IP19**	**IP20**
AC		✓	✓	✓	✓							✓	✓	✓	✓	✓	✓	✓		
AS		✓	✓	✓	✓								✓					✓		
DC	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓									
DS	✓	✓	✓	✓	✓															
CI						✓	✓	✓											✓	✓

(Source: Umweltbundesamt [10])

6.11.2 Overall scenario

Calculate the overlay of all routes with all aircraft types from Chapter 6.7 to 6.9 for all 20 IP.

6.12 Reference results, result levels

6.12.1 Single event level (L_{pAE} in dB) per aircraft type

As single event levels, the following results are obtained for each route and aircraft type at the immission points:

Table 6.12.1-1: Result level A320 (Source: Umweltbundesamt [10])

Route	A320																			
	IP01	IP02	IP03	IP04	IP05	IP06	IP07	IP08	IP09	IP10	IP11	IP12	IP13	IP14	IP15	IP16	IP17	IP18	IP19	IP20
AC		83.6	97.2	74.5	54.2							70.6	62.9	63.8	69.9	62.6	62.6	90.8		
AS		83.6	97.2	74.5	54.2								69.8					90.8		
DC	84.0	98.3	69.9	80.7	87.9	81.6	68.0	69.5	74.8	68.4	68.4									
DS	88.5	98.3	69.8	80.7	88.0															
CI						67.9	80.6	62.5											68.3	74.5

Table 6.12.1-2: Result level CRJ9 (Source: Umweltbundesamt [10])

Route	CRJ9																			
	IP01	IP02	IP03	IP04	IP05	IP06	IP07	IP08	IP09	IP10	IP11	IP12	IP13	IP14	IP15	IP16	IP17	IP18	IP19	IP20
AC		80.9	95.9	72.4	51.5							72.7	63.3	63.6	70.0	60.7	60.6	89.9		
AS		80.9	95.9	72.4	51.5								71.2					89.9		
DC	78.1	92.8	64.5	75.5	82.0	79.7	65.4	67.1	73.0	65.1	65.1									
DS	83.1	92.8	64.5	75.5	82.0															
CI						65.7	79.5	60.7											66.5	76.0

Table 6.12.1-3: Result level DH8C (Source: Umweltbundesamt [10])

Route	DH8C																			
	IP01	IP02	IP03	IP04	IP05	IP06	IP07	IP08	IP09	IP10	IP11	IP12	IP13	IP14	IP15	IP16	IP17	IP18	IP19	IP20
AC		67.9	84.6	57.0	33.4							44.5	37.7	40.8	60.5	54.9	54.9	75.4		
AS		67.9	84.6	57.0	32.0								43.7					75.4		
DC	66.5	86.2	74.6	71.0	75.5	67.3	59.1	61.6	57.6	53.3	53.5									
DS	68.8	86.2	74.6	71.0	75.5															
CI						53.5	61.3	53.4											60.8	55.1

6.12.2 Total level

The calculation of the cumulative levels is described in Chapter 27 [3]. The corresponding equations to be applied are 62 to 64 [3].

Here the total levels L_{DEN} and L_N are formed from the single event levels according to Chapter 6.12.1 with the flight motion numbers from Chapter 6.6. They give the following results:

Table 6.12.2-1: Total level (Source: Umweltbundesamt [10])

Level [dB]	Points of immission (IP)									
	IP01	IP02	IP03	IP04	IP05	IP06	IP07	IP08	IP09	IP10
L_{DEN}	65.0	76.7	76.3	60.3	66.1	58.0	56.1	46.4	50.9	44.1
L_N	59.1	70.8	70.0	54.1	60.2	52.0	50.0	40.4	45.0	38.2

Level [dB]	Points of immission (IP)									
	IP11	IP12	IP13	IP14	IP15	IP16	IP17	IP18	IP19	IP20
L_{DEN}	44.1	49.1	47.8	41.1	46.8	38.9	38.8	70.1	37.3	38.9
L_N	38.2	42.8	41.5	34.8	40.5	32.6	32.5	63.7	29.9	26.8

6.13 Reference results, example for intermediate results

6.13.1 Geometry of the trajectory segments

Annex A gives the intermediate results for the combinations of routes (AC, AS, DC, DS, CI) and aircraft type (A320, CRJ9, DH8C) in the tables, independent of the immission point. In Annex B, the resulting acoustic parameters at the respective immission points are listed in detailed tabular form for the comprehension of the calculation steps.

In the following Chapter 6.13.1, the formation of the flight path segments for the A320 take-off and the Route DS (**CASE_ID**: A320 DS) is explained in detail.

6.13.1.1 Fixed point profile

As a starting point for the calculation of the flight track segmentation, information on the fixed-point profile of the aircraft type A320 under consideration here (ACFT_ID: A320-232) can be found in Appendix 1 to [3] in Table 1-5 under the procedure "S" ("S" in this case stands for "take-off").

Table 6.13.1-1: Fixed point profile (Source: Umweltbundesamt [10])

ACFT_ID	Procedure	Section length	Step	Distance [m]	Height [m]	TAS [m/s]	Propulsion [N per engine]
A320-232	S	1	1	0.00	0.00	0.00	110,076.05
A320-232	S	1	2	1,812.25	0.00	83.69	91,647.07
A320-232	S	1	3	3,684.54	304.80	84.93	93,041.18
A320-232	S	1	4	5,921.41	413.31	109.72	88,301.13
A320-232	S	1	5	6,829.78	455.80	118.05	86,754.18
A320-232	S	1	6	7,134.58	487.56	118.26	67,774.02
A320-232	S	1	7	11,232.95	914.40	120.73	70,274.67
A320-232	S	1	8	13,431.99	992.76	133.74	70,245.53
A320-232	S	1	9	20,364.82	1,676.40	138.32	73,361.45
A320-232	S	1	10	26,970.56	2,286.00	142.59	75,596.80
A320-232	S	1	11	35,998.65	3,048.00	148.25	77,670.82

6.13.1.2 Geometry

The route geometry of the flight track DS is simple according to Chapter 6.6.2.1 and consists of the two support points.

	x [m]	y [m]
1. support point	0.00	0.00
2. support point	100,000.00	0.00

(Source: Umweltbundesamt [10])

6.13.1.3 Merging

Both sources of information (fixed point profile and route geometry) are "merged" with each other and lead to the first (approx.) division of the flight track.

Table 6.13.1-2: Segmentation of the flight track (approx.) (Source: Umweltbundesamt [10])

Step	Distance [m]	x [m]	y [m]	Height [m]	TAS [m/s]	Propulsion [N per engine]
1	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**110,076.05**
2	1,812.25	1,812.25	0.00	0.00	83.69	91,647.07
3	3,684.54	3,684.54	0.00	304.80	84.93	93,041.18
4	5,921.41	5,921.41	0.00	413.31	109.72	88,301.13
5	6,829.78	6,829.78	0.00	455.80	118.05	86,754.18
6	7,134.58	7,134.58	0.00	487.56	118.26	67,774.02
7	11,232.95	11,232.95	0.00	914.40	120.73	70,274.67
8	13,431.99	13,431.99	0.00	992.76	133.74	70,245.53
9	20,364.82	20,364.82	0.00	1,676.40	138.32	73,361.45
10	26,970.56	26,970.56	0.00	2,286.00	142.59	75,596.80
11	**35,998.65**	**35,998.65**	**0.00**	**3,048.00**	**148.25**	**77,670.82**

6.13.1.4 Ground roll runway

The take-off procedure up to take-off requires an additional subdivision of the "take-off roll distance" according to chapter 15 [3] under "Segmentation of the take-off roll distance". The application of the equations 2.7.10 to 2.7.13 mentioned there leads to the additional subdivision of the "previous" segment nodes "1" and "2". In the table below, the necessary sub-steps for the use of the cited equations have been worked through in a comprehensible manner. Their application leads to the additional nodes highlighted in yellow in the table:

	V_1	0.00	m/s
	V_2	83.69	m/s
(2.7.10)	n_{TO}	9.00	
(2.7.11)	DV	9.30	m/s
(2.7.14)	DP	-2,047.66	
	s_{TO}	1,812.25	m
1. Segment:	k	1.00	
(2.7.13)	$s_{TO,1}$	22.37	m
	Distance	22.37	m
	TAS	9.30	m/s
	Thrust	108,028	N
2. Segment:	k	2.00	
(2.7.13)	$s_{TO,1}$	67.12	m
	Distance	89.49	m
	TAS	18.60	m/s
	Thrust	105,981	N
(...)			
9. Segment:	k	9.00	
(2.7.13)	$s_{TO,1}$	380.35	m
	Distance	1,812.25	m
	TAS	83.69	m/s
	Thrust	91,647	N

Step	Distance [m]	x [m]	y [m]	Height [m]	Length [m]	TAS [m/s]	Propulsion [N per engine]
1	0.00	0.00	0.00	0.00	22.37	0.00	110,076.05
2	22.37	22.37	0.00	0.00	67.12	9.30	108,028.37
3	89.49	89.49	0.00	0.00	111.87	18.60	105,980.73
4	201.36	201.36	0.00	0.00	156.61	27.90	103,933.04
5	357.98	357.98	0.00	0.00	201.36	37.20	101,885.40
6	559.34	559.34	0.00	0.00	246.11	46.49	99,837.72
7	805.44	805.44	0.00	0.00	290.85	55.79	97,790.08
8	1,096.30	1,096.30	0.00	0.00	335.60	65.09	95,742.39
9	1,431.90	1,431.90	0.00	0.00	380.35	74.39	93,694.75
10	1,812.25	1,812.25	0.00	0.00		83.69	91,647.07

(Source: Umweltbundesamt [10])

6.13.1.5 Initial C limb

The further segmentation of the initial climb segment is now based on the approach described in Chapter 15 [3] in the subsection "Segmentation of the initial climb segment ...".

It should be noted that equation 2.7.15 applies to all segments of the flight lane and therefore additional nodes may arise outside the initial climb segment. In this case, the start index for the loop to calculate the additional nodes is greater than 1 because the aircraft is already in the air.

Note:

„denotes the index of the first member of the set of height values for which the calculated zk is strictly greater than the endpoint height of the previous original climb segment or the start-point height of the next original approach segment to be sub-segmented. In the specific case of an initial climb segment or last approach segment, k = 1, but in the more general case of airborne segments not connected to the runway, k will be greater than 1“. (ECAC 4th (see p. 24))

The described procedure with application of equation 2.7.15 leads to the intermediate results listed in the table below and the corresponding additional nodes (highlighted in yellow). It becomes clear how the nodes from the description of the fixed-point profile and the description of the initial climb segmentation interlock and lead to the corresponding nodes in the segmentation.

Segment initial climb

Adjacent profile points:	Distance [m]	x [m]	y [m]	Height [m]	Length [m]	TAS [m/s]	Propulsion [N per engine]
2	1,812.25	1,812.25	0.00	0.00	107.02	83.69	91,647.07
3	3,684.54	3,684.54	0.00	304.80	683.12	84.93	93,041.18

Intermediate nodes (initial climb segment) based on altitude values:

(2.7.15)		z	z_i	z_N	z_i'	
i	1	304.80	18.898	334.9752	17.20	m
i	2	304.80	41.453	334.9752	37.72	m
i	3	304.80	68.275	334.9752	62.12	m
i	4	304.80	102.11	334.9752	92.91	m
i	5	304.80	147.52	334.9752	134.23	m
i	6	304.80	214.88	334.9752	195.53	m

i = 1

	Distance	1,917.88	m
(2.7.9)	f	0.0564	
(2.7.6)	TAS	83.76	m/s
(2.7.8)	Thrust	91,726	N

1,917.88	1,917.88	0.00	17.20	127.73	83.76	91,726.29

The other intermediate nodes up to i = 6 must be determined analogously.

Further intermediate nodes ("airborne" segments):

Adjacent profile points:	Distance [m]	x [m]	y [m]	Height [m]	Length [m]	TAS [m/s]	Propulsion [N per engine]
6	7,134.58	7,134.58	0.00	487.56	143.87	118.26	67,774.02
7	11,232.95	11,232.95	0.00	914.40	1,072.09	120.73	70,274.67

	Distance	7,277.66	m
(2.7.9)	f	0.0349	
(2.7.6)	TAS	118.35	m/s
(2.7.8)	Thrust	67,863	N

7,277.66	7,277.66	0.00	502.46	3,976.67	118.35	67,862.88

Last intermediate nodes:

Adjacent profile points:	Distance [m]	x [m]	y [m]	Height [m]	Length [m]	TAS [m/s]	Propulsion [N per engine]
8	13,431.99	13,431.99	0.00	992.76	3,024.96	133.74	70,245.53
9	20,364.82	20,364.82	0.00	1,676.40	6,633.81	138.32	73,361.45

	Distance	16,442.35	m
(2.7.9)	f	0.43	
(2.7.6)	TAS	135.75	m/s
(2.7.8)	Thrust	71,615	N

16,442.35	16,442.35	0.00	1,289.61	3,941.49	135.75	71,615.17

Nodes

	Distance [m]	x [m]	y [m]	Height [m]	Length [m]	TAS [m/s]	Thrust [N per engine]
from Fixed_Point profile	1,812.25	1,812.25	0.00	0.00	107.02	83.69	91,647.07
initial climb	1,917.88	1,917.88	0.00	17.20	127.73	83.76	91,726.29
initial climb	2,043.94	2,043.94	0.00	37.72	151.89	83.84	91,820.73
initial climb	2,193.86	2,193.86	0.00	62.12	191.59	83.94	91,932.95
initial climb	2,382.97	2,382.97	0.00	92.91	257.18	84.07	92,074.27
initial climb	2,636.81	2,636.81	0.00	134.23	381.46	84.24	92,263.63
initial climb	3,013.31	3,013.31	0.00	195.53	680.07	84.49	92,543.78
from Fixed_Point profile	3,684.54	3,684.54	0.00	304.80	683.12	84.93	93,041.18
from Fixed_Point profile	5,921.41	5,921.41	0.00	413.31	909.36	109.72	88,301.13
from Fixed_Point profile	6,829.78	6,829.78	0.00	455.80	306.45	118.05	86,754.18
from Fixed_Point profile	7,134.58	7,134.58	0.00	487.56	143.87	118.26	67,774.02
initial climb/airborne segment	7,277.67	7,277.67	0.00	502.46	3,976.67	118.35	67,862.88
from Fixed_Point profile	11,232.95	11,232.95	0.00	914.40	1,072.09	120.73	70,274.67
from Fixed_Point profile	13,431.99	13,431.99	0.00	992.76	3,024.96	133.74	70,245.53
fix initial climb (1.289,61m)	16,442.35	16,442.35	0.00	1,289.61	3,941.49	135.75	71,615.17
from Fixed_Point profile	20,364.82	20,364.82	0.00	1,676.40	6,633.81	138.32	73,361.45
from Fixed_Point profile	26,970.56	26,970.56	0.00	2,286.00	9,060.19	142.59	75,596.80
from Fixed_Point profile	35,998.65	35,998.65	0.00	3,048.00	64,228.92	148.25	77,670.82

(Source: Umweltbundesamt [10])

6.13.1.6 Airborne Segments - Other Flight Segments

After modelling the take-off control process and the initial partial flight, the segmentation of the further flight route remains until the end of the specified flight route DS. This is done in Chapter 15 [3] and there in "Subsection Segmentation of Flight Segments" in particular by applying equation 2.7.16. The change in speed (and thus the thrust values) is in particular being taken into account. This results in additional segments - referred to as the "airborne segment" in the table below - which now complete the segmentation of the entire route.

	Distance [m]	x [m]	y [m]	Height [m]	Length [m]	TAS [m/s]	Thrust [N per engine]
from Fixed_Point profile	3,684.54	3,684.54	0.00	304.80	683.12	84.93	93,041.18
from Fixed_Point profile	5,921.41	5,921.41	0.00	413.31	909.36	109.72	88,301.13

(2.7.16)	n_{seg}	3	
(2.7.11)	DV	8.26	m/s
	s_{TO}	2236.87	m
1. Segment:	k	1	
(2.7.13)	$s_{TO,1}$	682.32	m
	Distance	4366.86	m
	TAS	93.19	m/s
	Thrust	91621	N
1. Segment:	k	2	
(2.7.13)	$s_{TO,1}$	745.62	m
	Distance	5112.48	m
	TAS	101.46	m/s
	Thrust	90044	N

(...)

	Distance [m]	x [m]	y [m]	Height [m]	Length [m]	TAS [m/s]	Thrust [N per engine]
from Fixed_Point profile	1,812.25	1,812.25	0.00	0.00	107.02	83.69	91,647.07
initial climb	1,917.88	1,917.88	0.00	17.20	127.73	83.76	91,726.29
initial climb	2,043.94	2,043.94	0.00	37.72	151.89	83.84	91,820.73
initial climb	2,193.86	2,193.86	0.00	62.12	191.59	83.94	91,932.95
initial climb	2,382.97	2,382.97	0.00	92.91	257.18	84.07	92,074.27
initial climb	2,636.81	2,636.81	0.00	134.23	381.46	84.24	92,263.63
initial climb	3,013.31	3,013.31	0.00	195.53	680.07	84.49	92,543.78
from Fixed_Point profile	3,684.54	3,684.54	0.00	304.80	683.12	84.93	93,041.18
airborne segment	4,366.86	4,366.86	0.00	337.90	746.50	93.19	91,621.30
airborne segment	5,112.48	5,112.48	0.00	374.07	809.88	101.46	90,044.10
from Fixed_Point profile	5,921.41	5,921.41	0.00	413.31	909.36	109.72	88,301.13
from Fixed_Point profile	6,829.78	6,829.78	0.00	455.80	306.45	118.05	86,754.18
from Fixed_Point profile	7,134.58	7,134.58	0.00	487.56	143.87	118.26	67,774.02
initial climb/airborne segment	7,277.67	7,277.67	0.00	502.46	3,976.67	118.35	67,862.88
from Fixed_Point profile	11,232.95	11,232.95	0.00	914.40	1,072.09	120.73	70,274.67
airborne segment	12,304.36	12,304.36	0.00	952.58	1,128.34	127.23	70,260.47
from Fixed_Point profile	13,431.99	13,431.99	0.00	992.76	3,024.96	133.74	70,245.53
fix initial climb (1.289,61m)	16,442.35	16,442.35	0.00	1,289.61	3,941.49	135.75	71,615.17
from Fixed_Point profile	20,364.82	20,364.82	0.00	1,676.40	6,633.81	138.32	73,361.45
from Fixed_Point profile	26,970.56	26,970.56	0.00	2,286.00	9,060.19	142.59	75,596.80
from Fixed_Point profile	35,998.65	35,998.65	0.00	3,048.00	64,228.92	148.25	77,670.82

(Source: Umweltbundesamt [10])

For the sake of completeness, the end point of the route at x = 100,000 m and an altitude of z = 8,576 m must also be given (cf. Annex A).
With the segmentation of take-off roles via initial partial flight and the flight segments up to the end point of the route described, the segmentation of a flight route (here DS) for an aircraft type (here A320) - possibly an aircraft class - independent of the immission point is completed. This is followed by the assignment of the acoustic parameters to the respective segments (depending on the immission point under consideration), which is described as an example in the following chapter.

6.13.2 Acoustic partial results

For IP05, Annex B lists the partial acoustic results for the launch of the A320 (**CASE_ID**: A320 DS). Below the formation of the acoustic partial results is explained in more detail. The equations quoted refer to [3] unless otherwise stated.

1) Base level and associated atmospheric correction (Chapter 18 [3])
   - NPD maximum level ("Lmax_noise_fraction")
     NPD sound exposure level („*baseline_SEL*")
     the "actual" base level for maximum and sound exposure levels calculated from the base levels of the ANP database tables. The calculation is performed as a function of the respective thrust and the shortest distance between the immission site and an infinite trajectory from the NPD curves according to the interpolation equations 22 and 23 (or 24 and 25) from [3].

   - „*acoustic_impedance adjustment*"
     Consideration of atmospheric conditions at the point of immission (eq. 2.7.23).
     The value depends exclusively on air pressure and temperature and is therefore the same for all segments (for the standard conditions in the example (101.325 kPa, 15° C) approximately 0.07 dB).

2) Corrections with regard to the specifications for the calculation of base levels (Chapter 21 [3])
   - Continuous correction ("speed_corr")
     Consideration of the deviation of the equivalent segment velocity from the reference velocity (82.31 m/s, eq. 2.7.36). This correction has the highest value at the start roll and decreases with increasing speed. In segment 9, the aircraft reaches the reference speed and therefore changes the sign.
     <u>Note:</u> applies only to sound exposure levels

   - Correction due to the installation of the engine ("engine_install_correction")
     Consideration of installation effects (lateral directional characteristic, eq. 2.7.37).
     The value is determined by the depression angle ϕ, which is composed of the elevation angle β (angle between the direct sound propagation path and the base plane) and the cross slope angle ε.

   - „*Lateral_attenuation*"
     Since the base levels of the ANP database refer to receivers below the aircraft, any lateral offset of the point of immission from the flight path must be taken into account. This value is determined by the lateral distance of the point of immission and the respective elevation angle (eq. 2.7.40). Since the example shows a straight flight path, the lateral offset is always the same, i.e. the value is determined exclusively by the elevation angle and therefore decreases steadily.

From segment 24 the elevation angle is greater than 50° and the correction is therefore equal to 0.

- Correction for finite segment ("*noise_fraction*")
  The calculated base levels refer to an infinite trajectory. Since a segment level is ultimately to be calculated, it must be determined which portion of the noise energy incident at the point of immission is caused by the respective segment (eq. 2.7.45 and 2.7.46). Depending on segment length and distance from the point of immission, the amount of correction decreases continuously and is lowest near the point of immission (segment 15) and then increases again.
  Note: applies only to sound exposure levels

- Directional function at the start of roll point ("start_of_roll_correction")
  Consideration of the longitudinal directional characteristic behind the start of the take-off run (eq. 2.7.49 – 2.7.52). The directivity function is important for immission points behind the start-of-roll point, but since IP 05 is located before the start-of-roll point (at the side of the opposite end of the runway), this value is always 0.

3) Segment level (Chapter 19 [3])
   - Segment level (*"segment_SEL"*)
     is the result of summing the sound exposure baseline levels and the corresponding corrections (eq. 2.7.28), in the example for the first segment:
     (92,32 + 0,07) + 12,48 – 1,50 – 8,82 – 47,32 + 0,0 = 47,23

6.13.3 Input parameters for determining the acoustic correction values

In order to be able to reproduce the partial acoustic results from Chapter 6.13.2 for IP05, Appendix C for the launch of A320 (**CASE_ID**: A320 DS) lists all relevant input parameters for determining the load.

1) Geometric flight segment parameters (Chapter 20, Figures 10 to 12 [3])
   - „slant_distance“
     the vertical distance d_p between the immission site and the extended segment in m
   - "distance_d1“
     The distance d1 between the starting point of the segment and the immission point in m
   - "distance_d2“
     The distance d_2 between the end point of the segment and the immission point in m
   - "distance_q“
     The distance q between the starting point of the segment (S1) and the point of the smallest flyby distance (S_p).
   - "lateral_displacement“
     The "slant_distance" measured in the xy plane

2) Input data for NPD interpolation (Chapter 20 [3])
   - "NPD_interpolation_distance“
     NPD distance parameters d. For the calculation of the sound exposure level for flight segments, d is equal to the minimum inclination distance d_p. For ground segments where the point of immission is behind the segment, d is the shortest distance between the point of immission and segment d_s.
   - "NPD_interpolation_thrust“
     Segment power P interpolated according to equation 34 [3] from the segment powers at the start point (P1) and at the end point (P2).

3) Various angles (Chapter 21 [3])
   - "angle_beta“
     Height angle β according to Figure 16 [3]
   - "angle_gamma“
     Climbing angle γ according to Figure 2 [3]
   - "angle_phi“
     Depression angle ϕ according to Figure 13 [3] Results as the sum of the elevation angle β and the transverse slope angle Ɛ
   - "bank_angle“
     Cross slope angle Ɛ according to Figure 2 [3]

6.14 Appendix

6.14.1 Appendix A (normative)

Table 6.14.1-1: CASE_ID: A320 AC (Source: Umweltbundesamt [10])

case_ID	segment_ID	sigma (m)	segment_start_x(m)	segment_start_y(m)	segment_start_z(m)	segment_length(m)	True Airspeed (m/s)	NPD_interpolation_thrust(N)
A320 AC	1	-1248,05	1248,05	0,00	0,00		15,28	11788
A320 AC	2	-1180,19	1180,19	0,00	0,00	67,86	23,85	21611
A320 AC	3	-1082,58	1082,58	0,00	0,00	97,60	32,42	31434
A320 AC	4	-955,24	955,24	0,00	0,00	127,34	41,00	41257
A320 AC	5	-798,16	798,16	0,00	0,00	157,08	49,57	51080
A320 AC	6	-611,35	611,35	0,00	0,00	186,82	58,14	60903
A320 AC	7	-394,79	394,79	0,00	0,00	216,56	66,72	70726
A320 AC	8	-300,00	300,00	0,00	0,00	94,79	68,26	19545
A320 AC	9	27,96	-27,96	0,00	17,19	328,40	68,32	19588
A320 AC	10	419,38	-419,38	0,00	37,70	391,97	68,38	19639
A320 AC	11	884,87	-884,87	0,00	62,10	466,12	68,46	19699
A320 AC	12	1472,01	-1472,01	0,00	92,87	587,95	68,57	19775
A320 AC	13	2260,16	-2260,16	0,00	134,17	789,23	68,70	19877
A320 AC	14	3429,16	-3429,16	0,00	195,44	1170,60	68,90	20026
A320 AC	15	5513,26	-5513,26	0,00	304,66	2086,96	69,26	20290
A320 AC	16	10279,18	-10279,18	0,00	554,43	4772,46	70,06	20882
A320 AC	17	11423,28	-11423,28	0,00	614,39	1145,67	73,76	14576
A320 AC	18	11728,08	-11728,08	0,00	630,36	305,22	74,69	4
A320 AC	19	13304,28	-13304,28	0,00	712,97	1578,36	83,12	4
A320 AC	20	15048,94	-15048,94	0,00	804,40	1747,06	91,56	4
A320 AC	21	18500,00	-18500,00	0,00	985,26	3455,80	95,00	4
A320 AC	22	19599,56	-19593,98	-95,71	1042,89	1099,67	96,07	4
A320 AC	23	20699,12	-20654,73	-379,94	1100,52	1099,67	97,13	4
A320 AC	24	21798,67	-21650,00	-844,04	1158,14	1099,67	98,18	4
A320 AC	25	22898,23	-22549,56	-1473,92	1215,77	1099,67	99,22	4
A320 AC	26	22963,71	-22595,81	-1520,16	1219,20	65,49	99,28	4
A320 AC	27	23997,79	-23326,08	-2250,44	1219,20	1032,76	105,48	4
A320 AC	28	24349,54	-23527,58	-2538,21	1219,20	351,31	107,51	4
A320 AC	29	25097,34	-23955,96	-3150,00	1219,20	746,85	111,35	4
A320 AC	30	26196,90	-24420,06	-4145,27	1219,20	1098,16	116,76	4
A320 AC	31	27296,46	-24704,29	-5206,02	1219,20	1098,16	121,94	4
A320 AC	32	28396,02	-24800,00	-6300,00	1219,20	1098,16	126,90	4
A320 AC	33	30031,99	-24800,00	-7935,97	1219,20	1635,97	133,95	4
A320 AC	34	30336,79	-24800,00	-8240,77	1219,20	304,80	135,24	18315
A320 AC	35	60816,79	-24800,00	-38720,77	1219,20	30480,00	135,24	18315
A320 AC	36	128396,02	-24800,00	-106300,00	1219,20	67579,23		

Table 6.14.1-2: CASE_ID: A320 AS (Source: Umweltbundesamt [10])

case_ID	segment_ID	sigma (m)	segment_start_x(m)	segment_start_y(m)	segment_start_z(m)	segment_length(m)	True Airspeed (m/s)	NPD_interpolation_thrust(N)
A320 AS	1	-1248,05	1248,05	0,00	0,00		15,28	11788
A320 AS	2	-1180,19	1180,19	0,00	0,00	67,86	23,85	21611
A320 AS	3	-1082,58	1082,58	0,00	0,00	97,60	32,42	31434
A320 AS	4	-955,24	955,24	0,00	0,00	127,34	41,00	41257
A320 AS	5	-798,16	798,16	0,00	0,00	157,08	49,57	51080
A320 AS	6	-611,35	611,35	0,00	0,00	186,82	58,14	60903
A320 AS	7	-394,79	394,79	0,00	0,00	216,56	66,72	70726
A320 AS	8	-300,00	300,00	0,00	0,00	94,79	68,26	19545
A320 AS	9	27,96	-27,96	0,00	17,19	328,40	68,32	19588
A320 AS	10	419,38	-419,38	0,00	37,70	391,97	68,38	19639
A320 AS	11	884,87	-884,87	0,00	62,10	466,12	68,46	19699
A320 AS	12	1472,01	-1472,01	0,00	92,87	587,95	68,57	19775
A320 AS	13	2260,16	-2260,16	0,00	134,17	789,23	68,70	19877
A320 AS	14	3429,16	-3429,16	0,00	195,44	1170,60	68,90	20026
A320 AS	15	5513,26	-5513,26	0,00	304,66	2086,96	69,26	20290
A320 AS	16	10279,18	-10279,18	0,00	554,43	4772,46	70,06	20882
A320 AS	17	11423,28	-11423,28	0,00	614,39	1145,67	73,76	14576
A320 AS	18	11728,08	-11728,08	0,00	630,36	305,22	74,69	4
A320 AS	19	13304,28	-13304,28	0,00	712,97	1578,36	83,12	4
A320 AS	20	15048,94	-15048,94	0,00	804,40	1747,06	91,56	4
A320 AS	21	22963,71	-22963,71	0,00	1219,20	7925,64	99,28	4
A320 AS	22	24349,54	-24349,54	0,00	1219,20	1385,83	107,51	4
A320 AS	23	26105,42	-26105,42	0,00	1219,20	1755,87	116,32	4
A320 AS	24	27999,56	-27999,56	0,00	1219,20	1894,15	125,14	4
A320 AS	25	30031,99	-30031,99	0,00	1219,20	2032,42	133,95	4
A320 AS	26	30336,79	-30336,79	0,00	1219,20	304,80	135,24	18315
A320 AS	27	60816,79	-60816,79	0,00	1219,20	30480,00	135,24	18315
A320 AS	28	98500,00	-98500,00	0,00	1219,20	37683,21		

Table 6.14.1-3: CASE_ID: A320 DC (Source: Umweltbundesamt [10])

case_ID	segment_ID	sigma (m)	segment_start_x(m)	segment_start_y(m)	segment_start_z(m)	segment_length(m)	True Airspeed (m/s)	NPD_interpolation_thrust(N)
A320 DC	1	0,00	0,00	0,00	0,00	22,37	0,00	110076
A320 DC	2	22,37	22,37	0,00	0,00	67,12	9,30	108028
A320 DC	3	89,49	89,49	0,00	0,00	111,87	18,60	105981
A320 DC	4	201,36	201,36	0,00	0,00	156,61	27,90	103933
A320 DC	5	357,98	357,98	0,00	0,00	201,36	37,20	101885
A320 DC	6	559,34	559,34	0,00	0,00	246,11	46,50	99838
A320 DC	7	805,44	805,44	0,00	0,00	290,85	55,80	97790
A320 DC	8	1096,30	1096,30	0,00	0,00	335,60	65,09	95742
A320 DC	9	1431,90	1431,90	0,00	0,00	380,35	74,39	93695
A320 DC	10	1812,25	1812,25	0,00	0,00	107,02	83,69	91647
A320 DC	11	1917,87	1917,87	0,00	17,20	127,73	83,76	91726
A320 DC	12	2043,94	2043,94	0,00	37,72	151,89	83,85	91821
A320 DC	13	2193,86	2193,86	0,00	62,12	191,59	83,95	91933
A320 DC	14	2382,97	2382,97	0,00	92,91	257,18	84,07	92074
A320 DC	15	2636,81	2636,81	0,00	134,23	381,46	84,24	92264
A320 DC	16	3013,31	3013,31	0,00	195,53	680,07	84,49	92544
A320 DC	17	3684,54	3684,54	0,00	304,80	15,47	84,93	93041
A320 DC	18	3700,00	3700,00	0,00	305,55	530,30	85,12	93009
A320 DC	19	4230,35	4227,66	-46,16	331,28	569,16	91,60	91859
A320 DC	20	4799,56	4793,98	-95,71	358,89	534,59	98,07	90709
A320 DC	21	5334,20	5309,75	-233,91	384,82	564,86	103,79	89530
A320 DC	22	5899,11	5854,73	-379,94	412,23	22,29	109,50	88350
A320 DC	23	5921,41	5874,91	-389,35	413,31	908,21	109,72	88301
A320 DC	24	6829,78	6697,12	-772,75	455,80	169,60	118,05	86754
A320 DC	25	6998,67	6850,00	-844,04	473,40	136,47	118,17	76818
A320 DC	26	7134,58	6961,18	-921,89	487,56	967,65	118,26	67774
A320 DC	27	8098,23	7749,56	-1473,92	587,92	1104,12	118,85	68370
A320 DC	28	9197,79	8526,08	-2250,44	702,44	1104,12	119,51	69044
A320 DC	29	10297,34	9155,96	-3150,00	816,96	939,48	120,17	69712
A320 DC	30	11232,95	9550,86	-3996,87	914,40	163,85	120,73	70275
A320 DC	31	11396,90	9620,06	-4145,27	920,24	1098,86	121,75	70272
A320 DC	32	12496,46	9904,29	-5206,02	959,43	934,94	128,37	70258
A320 DC	33	13431,99	9985,72	-6136,80	992,76	164,62	133,74	70246
A320 DC	34	13596,02	10000,00	-6300,00	1008,94	2860,11	133,85	70321
A320 DC	35	16442,32	10000,00	-9146,31	1289,61	3941,52	135,75	71615
A320 DC	36	20364,82	10000,00	-13068,80	1676,40	6633,82	138,32	73361
A320 DC	37	26970,56	10000,00	-19674,55	2286,00	9060,18	142,59	75597
A320 DC	38	35998,65	10000,00	-28702,63	3048,00	77873,28	148,25	77671
A320 DC	39	113596,02	10000,00	-106300,00	9597,47			

Table 6.14.1-4: CASE_ID: A320 DS (Source: Umweltbundesamt [10])

case_ID	segment_ID	sigma (m)	segment_start_x(m)	segment_start_y(m)	segment_start_z(m)	segment_length(m)	True Airspeed (m/s)	NPD_interpolation_thrust(N)
A320 DS	1	0,00	0,00	0,00	0,00	22,37	0,00	110076
A320 DS	2	22,37	22,37	0,00	0,00	67,12	9,30	108028
A320 DS	3	89,49	89,49	0,00	0,00	111,87	18,60	105981
A320 DS	4	201,36	201,36	0,00	0,00	156,61	27,90	103933
A320 DS	5	357,98	357,98	0,00	0,00	201,36	37,20	101885
A320 DS	6	559,34	559,34	0,00	0,00	246,11	46,50	99838
A320 DS	7	805,44	805,44	0,00	0,00	290,85	55,80	97790
A320 DS	8	1096,30	1096,30	0,00	0,00	335,60	65,09	95742
A320 DS	9	1431,90	1431,90	0,00	0,00	380,35	74,39	93695
A320 DS	10	1812,25	1812,25	0,00	0,00	107,02	83,69	91647
A320 DS	11	1917,87	1917,87	0,00	17,20	127,73	83,76	91726
A320 DS	12	2043,94	2043,94	0,00	37,72	151,89	83,85	91821
A320 DS	13	2193,86	2193,86	0,00	62,12	191,59	83,95	91933
A320 DS	14	2382,97	2382,97	0,00	92,91	257,18	84,07	92074
A320 DS	15	2636,81	2636,81	0,00	134,23	381,46	84,24	92264
A320 DS	16	3013,31	3013,31	0,00	195,53	680,07	84,49	92544
A320 DS	17	3684,54	3684,54	0,00	304,80	683,11	84,93	93041
A320 DS	18	4366,85	4366,85	0,00	337,90	746,50	93,19	91461
A320 DS	19	5112,47	5112,47	0,00	374,07	809,89	101,46	89881
A320 DS	20	5921,41	5921,41	0,00	413,31	909,36	109,72	88301
A320 DS	21	6829,78	6829,78	0,00	455,80	306,45	118,05	86754
A320 DS	22	7134,58	7134,58	0,00	487,56	143,88	118,26	67774
A320 DS	23	7277,69	7277,69	0,00	502,46	3976,66	118,35	67863
A320 DS	24	11232,95	11232,95	0,00	914,40	1072,08	120,73	70275
A320 DS	25	12304,35	12304,35	0,00	952,58	1128,35	127,24	70260
A320 DS	26	13431,99	13431,99	0,00	992,76	3024,94	133,74	70246
A320 DS	27	16442,32	16442,32	0,00	1289,61	3941,52	135,75	71615
A320 DS	28	20364,82	20364,82	0,00	1676,40	6633,82	138,32	73361
A320 DS	29	26970,56	26970,56	0,00	2286,00	9060,18	142,59	75597
A320 DS	30	35998,65	35998,65	0,00	3048,00	65734,25	148,25	77671
A320 DS	31	101500,00	101500,00	0,00	8576,53			

Table 6.14.1-5: CASE_ID: A320 CI (1) (Source: Umweltbundesamt [10])

case_ID	segment_ID	sigma (m)	segment_start_x(m)	segment_start_y(m)	segment_start_z(m)	segment_length(m)	True Airspeed (m/s)	NPD_interpolation_thrust(N)
A320 CI	1	-1248,05	1751,95	0,00	0,00		15,28	11788
A320 CI	2	-1180,19	1819,81	0,00	0,00	67,86	23,85	21611
A320 CI	3	-1082,58	1917,42	0,00	0,00	97,60	32,42	31434
A320 CI	4	-955,24	2044,76	0,00	0,00	127,34	41,00	41257
A320 CI	5	-798,16	2201,84	0,00	0,00	157,08	49,57	51080
A320 CI	6	-611,35	2388,65	0,00	0,00	186,82	58,14	60903
A320 CI	7	-394,79	2605,21	0,00	0,00	216,56	66,72	70726
A320 CI	8	-300,00	2700,00	0,00	0,00	94,79	68,26	19545
A320 CI	9	122,13	3122,13	0,00	22,12	422,71	68,33	19600
A320 CI	10	625,96	3625,96	0,00	48,53	504,52	68,42	19666
A320 CI	11	1225,11	4225,11	0,00	79,93	599,97	68,52	19743
A320 CI	12	1980,85	4980,85	0,00	119,53	756,78	68,65	19841
A320 CI	13	2995,32	5995,32	0,00	172,70	1015,86	68,83	19971
A320 CI	14	4500,00	7500,00	0,00	251,56	1506,75	69,08	20163
A320 CI	15	5023,60	8020,94	-45,58	279,00	523,65	69,17	20229
A320 CI	16	5547,20	8526,06	-180,92	306,44	523,65	69,26	20295
A320 CI	17	6070,80	9000,00	-401,92	333,88	523,65	69,35	20361
A320 CI	18	6594,40	9428,36	-701,87	361,32	523,65	69,44	20426
A320 CI	19	7117,99	9798,13	-1071,64	388,76	523,65	69,53	20491
A320 CI	20	7641,59	10098,08	-1500,00	416,20	523,65	69,62	20557
A320 CI	21	8165,19	10319,08	-1973,94	443,64	523,65	69,71	20621
A320 CI	22	8688,79	10454,42	-2479,06	471,08	523,65	69,79	20686
A320 CI	23	9212,39	10500,00	-3000,00	498,52	523,65	69,88	20751
A320 CI	24	9735,99	10454,42	-3520,94	525,96	523,65	69,97	20815
A320 CI	25	10259,59	10319,08	-4026,06	553,40	523,65	70,06	20879
A320 CI	26	10279,18	10310,81	-4043,80	554,43	19,59	70,06	20882
A320 CI	27	10783,19	10098,08	-4500,00	580,85	504,06	71,71	18372
A320 CI	28	11306,78	9798,13	-4928,36	608,29	523,65	73,39	15337
A320 CI	29	11423,28	9715,86	-5010,63	614,39	116,51	73,76	14576
A320 CI	30	11728,08	9500,61	-5225,89	630,36	304,83	74,69	4
A320 CI	31	11830,38	9428,36	-5298,13	635,72	102,31	75,27	4
A320 CI	32	12353,98	9000,00	-5598,08	663,16	523,65	78,15	4
A320 CI	33	12877,58	8526,06	-5819,08	690,60	523,65	80,93	4
A320 CI	34	13401,18	8020,94	-5954,42	718,04	523,65	83,62	4
A320 CI	35	13924,78	7500,00	-6000,00	745,49	523,65	86,22	4
A320 CI	36	15048,94	6375,84	-6000,00	804,40	1125,70	91,56	4
A320 CI	37	17147,83	4276,95	-6000,00	914,40	2101,77	93,67	4
A320 CI	38	21351,71	73,06	-6000,00	914,40	4203,88	102,27	27369
A320 CI	39	25924,78	-4500,00	-6000,00	914,40	4573,06	110,87	54734
A320 CI	40	26448,38	-5020,94	-5954,42	914,40	522,93	111,82	56343
A320 CI	41	26971,97	-5526,06	-5819,08	914,40	522,93	112,75	57907

Table 6.14.1-6: CASE_ID: A320 CI (2) (Source: Umweltbundesamt [10])

case_ID	segment_ID	sigma (m)	segment_start_x(m)	segment_start_y(m)	segment_start_z(m)	segment_length(m)	True Airspeed (m/s)	NPD_interpolation_thrust(N)
A320 CI	42	27495,57	-6000,00	-5598,08	914,40	522,93	113,68	59430
A320 CI	43	28019,17	-6428,36	-5298,13	914,40	522,93	114,60	60915
A320 CI	44	28542,77	-6798,13	-4928,36	914,40	522,93	115,51	62365
A320 CI	45	29066,37	-7098,08	-4500,00	914,40	522,93	116,42	63781
A320 CI	46	29589,97	-7319,08	-4026,06	914,40	522,93	117,32	65167
A320 CI	47	30113,57	-7454,42	-3520,94	914,40	522,93	118,21	66524
A320 CI	48	30637,17	-7500,00	-3000,00	914,40	522,93	119,09	67854
A320 CI	49	31160,77	-7454,42	-2479,06	914,40	522,93	119,97	69159
A320 CI	50	31616,61	-7336,59	-2039,31	914,40	455,26	120,73	70275
A320 CI	51	31684,36	-7319,08	-1973,94	907,34	68,04	120,69	70234
A320 CI	52	32207,96	-7098,08	-1500,00	852,81	525,77	120,38	69919
A320 CI	53	32731,56	-6798,13	-1071,64	798,28	525,77	120,06	69603
A320 CI	54	33255,16	-6428,36	-701,87	743,75	525,77	119,75	69286
A320 CI	55	33778,76	-6000,00	-401,92	689,22	525,77	119,43	68967
A320 CI	56	34302,36	-5526,06	-180,92	634,68	525,77	119,12	68646
A320 CI	57	34825,96	-5020,94	-45,58	580,15	525,77	118,80	68324
A320 CI	58	35349,55	-4500,00	0,00	525,62	525,77	118,48	68001
A320 CI	59	35714,98	-4134,58	0,00	487,56	367,40	118,26	67774
A320 CI	60	36019,78	-3829,78	0,00	455,80	306,45	118,05	86754
A320 CI	61	36928,14	-2921,41	0,00	413,31	909,36	109,72	88301
A320 CI	62	37737,09	-2112,47	0,00	374,07	809,89	101,46	89881
A320 CI	63	38482,71	-1366,85	0,00	337,90	746,50	93,19	91461
A320 CI	64	39165,02	-684,54	0,00	304,80	683,11	84,93	93041
A320 CI	65	39836,25	-13,31	0,00	195,53	680,07	84,49	92544
A320 CI	66	40212,75	363,19	0,00	134,23	381,46	84,24	92264
A320 CI	67	40466,59	617,03	0,00	92,91	257,18	84,07	92074
A320 CI	68	40655,69	806,14	0,00	62,12	191,59	83,94	91933
A320 CI	69	40805,61	956,06	0,00	37,72	151,89	83,84	91821
A320 CI	70	40931,68	1082,12	0,00	17,20	127,73	83,76	91726
A320 CI	71	41037,30	1187,75	0,00	0,00	107,02	83,69	91647
A320 CI	72	41417,65	1568,10	0,00	0,00	380,35	74,39	93695
A320 CI	73	41753,26	1903,70	0,00	0,00	335,60	65,09	95742
A320 CI	74	42044,11	2194,56	0,00	0,00	290,85	55,79	97790
A320 CI	75	42290,22	2440,66	0,00	0,00	246,11	46,49	99838
A320 CI	76	42491,58	2642,02	0,00	0,00	201,36	37,19	101885
A320 CI	77	42648,19	2798,64	0,00	0,00	156,61	27,90	103933
A320 CI	78	42760,06	2910,51	0,00	0,00	111,87	18,60	105981
A320 CI	79	42827,18	2977,63	0,00	0,00	67,12	9,30	108028
A320 CI	80	42849,55	3000,00	0,00	0,00	22,37	0,00	110076

Table 6.14.1-7: CASE_ID: CRJ9 AC (Source: Umweltbundesamt [10])

case_ID	segment_ID	sigma (m)	segment_start_x(m)	segment_start_y(m)	segment_start_z(m)	segment_length(m)	True Airspeed (m/s)	NPD_interpolation_thrust(N)
CRJ9 AC	1	-1197,33	1197,33	0,00	0,00		15,28	6016
CRJ9 AC	2	-1138,20	1138,20	0,00	0,00	59,13	24,63	6016
CRJ9 AC	3	-1051,35	1051,35	0,00	0,00	86,85	33,98	6016
CRJ9 AC	4	-936,79	936,79	0,00	0,00	114,56	43,34	6016
CRJ9 AC	5	-794,51	794,51	0,00	0,00	142,28	52,69	6016
CRJ9 AC	6	-624,51	624,51	0,00	0,00	170,00	62,05	6016
CRJ9 AC	7	-426,80	426,80	0,00	0,00	197,71	71,40	6016
CRJ9 AC	8	-300,00	300,00	0,00	0,00	126,80	80,19	15832
CRJ9 AC	9	60,59	-60,59	0,00	18,90	361,08	79,99	15868
CRJ9 AC	10	490,97	-490,97	0,00	41,45	430,97	79,75	15911
CRJ9 AC	11	1002,77	-1002,77	0,00	68,28	512,50	79,47	15963
CRJ9 AC	12	1648,34	-1648,34	0,00	102,11	646,45	79,11	16027
CRJ9 AC	13	2514,91	-2514,91	0,00	147,52	867,76	78,62	16114
CRJ9 AC	14	3800,23	-3800,23	0,00	214,88	1287,09	77,90	16241
CRJ9 AC	15	6091,71	-6091,71	0,00	334,98	2294,62	76,59	16465
CRJ9 AC	16	11331,87	-11331,87	0,00	609,60	5247,35	73,51	16967
CRJ9 AC	17	18500,00	-18500,00	0,00	985,27	7177,97	74,88	17801
CRJ9 AC	18	19599,56	-19593,98	-95,71	1042,89	1099,67	75,09	17925
CRJ9 AC	19	20699,12	-20654,73	-379,94	1100,52	1099,67	75,30	18049
CRJ9 AC	20	21798,67	-21650,00	-844,04	1158,14	1099,67	75,51	18171
CRJ9 AC	21	22658,91	-22353,77	-1336,83	1203,23	860,33	75,67	18267
CRJ9 AC	22	22898,23	-22549,56	-1473,92	1215,77	239,34	75,71	18429
CRJ9 AC	23	22963,71	-22595,81	-1520,16	1219,20	65,49	75,72	18473
CRJ9 AC	24	23997,79	-23326,08	-2250,44	1219,20	1032,76	75,72	18473
CRJ9 AC	25	24182,91	-23432,13	-2401,89	1219,20	184,89	75,72	18473
CRJ9 AC	26	24487,71	-23606,73	-2651,25	1219,20	304,41	75,72	4
CRJ9 AC	27	25097,34	-23955,96	-3150,00	1219,20	608,86	83,74	4
CRJ9 AC	28	25627,61	-24179,78	-3629,98	1219,20	529,60	90,14	4
CRJ9 AC	29	26196,90	-24420,06	-4145,27	1219,20	568,57	96,54	4
CRJ9 AC	30	26731,50	-24558,25	-4661,00	1219,20	533,92	102,18	4
CRJ9 AC	31	27296,46	-24704,29	-5206,02	1219,20	564,25	107,82	4
CRJ9 AC	32	27833,81	-24751,06	-5740,64	1219,20	536,67	112,93	4
CRJ9 AC	33	28396,02	-24800,00	-6300,00	1219,20	561,50	118,04	4
CRJ9 AC	34	29256,86	-24800,00	-7160,84	1219,20	860,84	125,45	4
CRJ9 AC	35	30170,15	-24800,00	-8074,13	1219,20	913,29	132,87	4
CRJ9 AC	36	30474,95	-24800,00	-8378,93	1219,20	304,80	135,24	12398
CRJ9 AC	37	60954,95	-24800,00	-38858,93	1219,20	30480,00	135,24	12398
CRJ9 AC	38	128396,02	-24800,00	-106300,00	1219,20	67441,07		

Table 6.14.1-8: CASE_ID: CRJ9 AS (Source: Umweltbundesamt [10])

case_ID	segment_ID	sigma (m)	segment_start_x(m)	segment_start_y(m)	segment_start_z(m)	segment_length(m)	True Airspeed (m/s)	NPD_interpolation_thrust(N)
CRJ9 AS	1	-1197,33	1197,33	0,00	0,00		15,28	6016
CRJ9 AS	2	-1138,20	1138,20	0,00	0,00	59,13	24,63	6016
CRJ9 AS	3	-1051,35	1051,35	0,00	0,00	86,85	33,98	6016
CRJ9 AS	4	-936,79	936,79	0,00	0,00	114,56	43,34	6016
CRJ9 AS	5	-794,51	794,51	0,00	0,00	142,28	52,69	6016
CRJ9 AS	6	-624,51	624,51	0,00	0,00	170,00	62,05	6016
CRJ9 AS	7	-426,80	426,80	0,00	0,00	197,71	71,40	6016
CRJ9 AS	8	-300,00	300,00	0,00	0,00	126,80	80,19	15832
CRJ9 AS	9	60,59	-60,59	0,00	18,90	361,08	79,99	15868
CRJ9 AS	10	490,97	-490,97	0,00	41,45	430,97	79,75	15911
CRJ9 AS	11	1002,77	-1002,77	0,00	68,28	512,50	79,47	15963
CRJ9 AS	12	1648,34	-1648,34	0,00	102,11	646,45	79,11	16027
CRJ9 AS	13	2514,91	-2514,91	0,00	147,52	867,76	78,62	16114
CRJ9 AS	14	3800,23	-3800,23	0,00	214,88	1287,09	77,90	16241
CRJ9 AS	15	6091,71	-6091,71	0,00	334,98	2294,62	76,59	16465
CRJ9 AS	16	11331,87	-11331,87	0,00	609,60	5247,35	73,51	16967
CRJ9 AS	17	22658,91	-22658,91	0,00	1203,23	11342,59	75,67	18267
CRJ9 AS	18	22963,71	-22963,71	0,00	1219,20	305,22	75,72	18473
CRJ9 AS	19	24182,91	-24182,91	0,00	1219,20	1219,20	75,72	18473
CRJ9 AS	20	24487,71	-24487,71	0,00	1219,20	304,80	75,72	4
CRJ9 AS	21	25218,55	-25218,55	0,00	1219,20	730,84	85,24	4
CRJ9 AS	22	26035,88	-26035,88	0,00	1219,20	817,33	94,77	4
CRJ9 AS	23	26939,71	-26939,71	0,00	1219,20	903,83	104,29	4
CRJ9 AS	24	27930,03	-27930,03	0,00	1219,20	990,32	113,82	4
CRJ9 AS	25	29006,84	-29006,84	0,00	1219,20	1076,81	123,34	4
CRJ9 AS	26	30170,15	-30170,15	0,00	1219,20	1163,31	132,87	4
CRJ9 AS	27	30474,95	-30474,95	0,00	1219,20	304,80	135,24	12398
CRJ9 AS	28	60954,95	-60954,95	0,00	1219,20	30480,00	135,24	12398
CRJ9 AS	29	98500,00	-98500,00	0,00	1219,20	37545,05		

Table 6.14.1-9: CASE_ID: CRJ9 DC (Source: Umweltbundesamt [10])

case_ID	segment_ID	sigma (m)	segment_start_x(m)	segment_start_y(m)	segment_start_z(m)	segment_length(m)	True Airspeed (m/s)	NPD_interpolation_thrust(N)
CRJ9 DC	1	0,00	0,00	0,00	0,00	23,53	0,00	58914
CRJ9 DC	2	23,53	23,53	0,00	0,00	70,59	9,60	57521
CRJ9 DC	3	94,13	94,13	0,00	0,00	117,66	19,20	56128
CRJ9 DC	4	211,78	211,78	0,00	0,00	164,72	28,81	54735
CRJ9 DC	5	376,50	376,50	0,00	0,00	211,78	38,41	53342
CRJ9 DC	6	588,28	588,28	0,00	0,00	258,84	48,01	51949
CRJ9 DC	7	847,13	847,13	0,00	0,00	305,91	57,61	50556
CRJ9 DC	8	1153,04	1153,04	0,00	0,00	352,97	67,21	49163
CRJ9 DC	9	1506,01	1506,01	0,00	0,00	400,03	76,82	47771
CRJ9 DC	10	1906,04	1906,04	0,00	0,00	122,49	86,42	46378
CRJ9 DC	11	2027,18	2027,18	0,00	18,16	146,20	86,50	46430
CRJ9 DC	12	2171,76	2171,76	0,00	39,82	173,86	86,59	46493
CRJ9 DC	13	2343,70	2343,70	0,00	65,59	219,30	86,71	46568
CRJ9 DC	14	2560,58	2560,58	0,00	98,10	294,38	86,85	46662
CRJ9 DC	15	2851,71	2851,71	0,00	141,73	245,03	87,04	46788
CRJ9 DC	16	3093,36	3093,36	0,00	182,32	615,14	87,21	46902
CRJ9 DC	17	3700,00	3700,00	0,00	284,21	124,18	87,63	47187
CRJ9 DC	18	3822,62	3822,00	-10,67	304,80	467,99	87,71	47244
CRJ9 DC	19	4291,04	4288,05	-51,45	317,19	508,05	95,55	46185
CRJ9 DC	20	4799,56	4793,98	-95,71	330,65	157,48	103,40	45127
CRJ9 DC	21	4957,18	4946,04	-136,45	334,82	306,66	105,71	44776
CRJ9 DC	22	5261,98	5240,08	-215,24	371,89	641,03	105,91	38410
CRJ9 DC	23	5899,11	5854,73	-379,94	449,36	1106,27	106,32	38606
CRJ9 DC	24	6998,67	6850,00	-844,04	583,06	1106,27	107,02	38942
CRJ9 DC	25	8098,23	7749,56	-1473,92	716,76	1106,27	107,72	39275
CRJ9 DC	26	9197,79	8526,08	-2250,44	850,45	529,12	108,41	39605
CRJ9 DC	27	9723,70	8827,35	-2680,69	914,40	573,05	108,74	39762
CRJ9 DC	28	10297,34	9155,96	-3150,00	926,63	1098,41	114,07	39409
CRJ9 DC	29	11396,90	9620,06	-4145,27	950,06	1098,41	123,66	38723
CRJ9 DC	30	12496,46	9904,29	-5206,02	973,50	140,23	132,55	38024
CRJ9 DC	31	12636,83	9916,51	-5345,68	976,49	962,62	133,64	37934
CRJ9 DC	32	13596,02	10000,00	-6300,00	1071,04	2228,13	134,34	38164
CRJ9 DC	33	15813,40	10000,00	-8517,38	1289,61	8768,67	135,95	38690
CRJ9 DC	34	24539,77	10000,00	-17243,76	2149,78	9156,57	142,10	40688
CRJ9 DC	35	33652,18	10000,00	-26356,16	3048,00	80331,28	148,25	42686
CRJ9 DC	36	113596,02	10000,00	-106300,00	10928,16			

Table 6.14.1-10: CASE_ID: CRJ9 DS (Source: Umweltbundesamt [10])

case_ID	segment_ID	sigma (m)	segment_start_x(m)	segment_start_y(m)	segment_start_z(m)	segment_length(m)	True Airspeed (m/s)	NPD_interpolation_thrust(N)
CRJ9 DS	1	0,00	0,00	0,00	0,00	23,53	0,00	58913,65
CRJ9 DS	2	23,53	23,53	0,00	0,00	70,59	9,60	57520,76
CRJ9 DS	3	94,13	94,13	0,00	0,00	117,66	19,20	56127,88
CRJ9 DS	4	211,78	211,78	0,00	0,00	164,72	28,81	54735,00
CRJ9 DS	5	376,50	376,50	0,00	0,00	211,78	38,41	53342,11
CRJ9 DS	6	588,28	588,28	0,00	0,00	258,84	48,01	51949,23
CRJ9 DS	7	847,13	847,13	0,00	0,00	305,91	57,61	50556,34
CRJ9 DS	8	1153,04	1153,04	0,00	0,00	352,97	67,21	49163,46
CRJ9 DS	9	1506,01	1506,01	0,00	0,00	400,03	76,82	47770,58
CRJ9 DS	10	1906,04	1906,04	0,00	0,00	122,49	86,42	46377,69
CRJ9 DS	11	2027,18	2027,18	0,00	18,16	146,20	86,50	46430,47
CRJ9 DS	12	2171,76	2171,76	0,00	39,82	173,86	86,59	46493,40
CRJ9 DS	13	2343,70	2343,70	0,00	65,59	219,30	86,71	46568,11
CRJ9 DS	14	2560,58	2560,58	0,00	98,10	294,38	86,85	46662,19
CRJ9 DS	15	2851,71	2851,71	0,00	141,73	324,79	87,04	46788,17
CRJ9 DS	16	3172,02	3172,02	0,00	195,53	659,71	87,26	46938,97
CRJ9 DS	17	3822,62	3822,62	0,00	304,80	541,07	87,71	47243,80
CRJ9 DS	18	4363,50	4363,50	0,00	319,11	593,88	96,71	46009,98
CRJ9 DS	19	4957,18	4957,18	0,00	334,82	307,05	105,71	44776,16
CRJ9 DS	20	5261,98	5261,98	0,00	371,89	1081,77	105,91	38409,81
CRJ9 DS	21	6335,84	6335,84	0,00	502,46	3412,81	106,60	38739,66
CRJ9 DS	22	9723,70	9723,70	0,00	914,40	904,74	108,74	39762,37
CRJ9 DS	23	10628,23	10628,23	0,00	933,68	971,26	117,04	39152,85
CRJ9 DS	24	11599,28	11599,28	0,00	954,38	1037,79	125,34	38543,33
CRJ9 DS	25	12636,83	12636,83	0,00	976,49	3191,96	133,64	37933,81
CRJ9 DS	26	15813,40	15813,40	0,00	1289,61	8768,67	135,95	38689,53
CRJ9 DS	27	24539,77	24539,77	0,00	2149,78	9156,57	142,10	40687,58
CRJ9 DS	28	33652,18	33652,18	0,00	3048,00	68176,64	148,25	42685,64
CRJ9 DS	29	101500,00	101500,00	0,00	9735,85			

Table 6.14.1-11: CASE_ID: CRJ9 CI (1) (Source: Umweltbundesamt [10])

case_ID	segment_ID	sigma (m)	segment_start_x(m)	segment_start_y(m)	segment_start_z(m)	segment_length(m)	True Airspeed (m/s)	NPD_interpolation_thrust(N)
CRJ9 CI	1	-1197,33	1802,67	0,00	0,00		15,28	6016
CRJ9 CI	2	-1138,20	1861,80	0,00	0,00	59,13	24,63	6016
CRJ9 CI	3	-1051,35	1948,65	0,00	0,00	86,85	33,98	6016
CRJ9 CI	4	-936,79	2063,21	0,00	0,00	114,56	43,34	6016
CRJ9 CI	5	-794,51	2205,49	0,00	0,00	142,28	52,69	6016
CRJ9 CI	6	-624,51	2375,49	0,00	0,00	170,00	62,05	6016
CRJ9 CI	7	-426,80	2573,20	0,00	0,00	197,71	71,40	6016
CRJ9 CI	8	-300,00	2700,00	0,00	0,00	126,80	80,19	15832
CRJ9 CI	9	122,13	3122,13	0,00	22,12	422,71	79,96	15874
CRJ9 CI	10	625,96	3625,96	0,00	48,53	504,52	79,68	15925
CRJ9 CI	11	1225,11	4225,11	0,00	79,93	599,97	79,35	15985
CRJ9 CI	12	1980,85	4980,85	0,00	119,53	756,78	78,92	16061
CRJ9 CI	13	2995,32	5995,32	0,00	172,70	1015,86	78,35	16161
CRJ9 CI	14	4500,00	7500,00	0,00	251,56	1506,75	77,50	16310
CRJ9 CI	15	5023,60	8020,94	-45,58	279,00	523,65	77,20	16361
CRJ9 CI	16	5547,20	8526,06	-180,92	306,44	523,65	76,90	16412
CRJ9 CI	17	6070,80	9000,00	-401,92	333,88	523,65	76,60	16463
CRJ9 CI	18	6594,40	9428,36	-701,87	361,32	523,65	76,30	16514
CRJ9 CI	19	7117,99	9798,13	-1071,64	388,76	523,65	76,00	16565
CRJ9 CI	20	7641,59	10098,08	-1500,00	416,20	523,65	75,69	16615
CRJ9 CI	21	8165,19	10319,08	-1973,94	443,64	523,65	75,39	16666
CRJ9 CI	22	8688,79	10454,42	-2479,06	471,08	523,65	75,08	16716
CRJ9 CI	23	9212,39	10500,00	-3000,00	498,52	523,65	74,77	16766
CRJ9 CI	24	9735,99	10454,42	-3520,94	525,96	523,65	74,46	16816
CRJ9 CI	25	10259,59	10319,08	-4026,06	553,40	523,65	74,15	16866
CRJ9 CI	26	10783,19	10098,08	-4500,00	580,84	523,65	73,84	16915
CRJ9 CI	27	11306,78	9798,13	-4928,36	608,29	523,65	73,52	16965
CRJ9 CI	28	11331,87	9780,42	-4946,08	609,60	25,09	73,51	16967
CRJ9 CI	29	11830,38	9428,36	-5298,13	635,73	498,57	73,60	17026
CRJ9 CI	30	12353,98	9000,00	-5598,08	663,17	523,65	73,71	17089
CRJ9 CI	31	12877,58	8526,06	-5819,08	690,61	523,65	73,81	17150
CRJ9 CI	32	13401,18	8020,94	-5954,42	718,05	523,65	73,91	17212
CRJ9 CI	33	13924,78	7500,00	-6000,00	745,49	523,65	74,01	17273
CRJ9 CI	34	17147,77	4277,01	-6000,00	914,40	3227,41	74,62	17646
CRJ9 CI	35	19840,22	1584,56	-6000,00	914,40	2692,45	81,38	22352
CRJ9 CI	36	22765,89	-1341,11	-6000,00	914,40	2925,67	88,14	27057
CRJ9 CI	37	25924,78	-4500,00	-6000,00	914,40	3158,89	94,89	31762
CRJ9 CI	38	26448,38	-5020,94	-5954,42	914,40	522,93	95,97	32411

Table 6.14.1-12: CASE_ID: CRJ9 CI (2) (Source: Umweltbundesamt [10])

case_ID	segment_ID	sigma (m)	segment_start_x(m)	segment_start_y(m)	segment_start_z(m)	segment_length(m)	True Airspeed (m/s)	NPD_interpolation_thrust(N)
CRJ9 CI	39	26971,97	-5526,06	-5819,08	914,40	522,93	97,03	33046
CRJ9 CI	40	27495,57	-6000,00	-5598,08	914,40	522,93	98,08	33670
CRJ9 CI	41	28019,17	-6428,36	-5298,13	914,40	522,93	99,12	34282
CRJ9 CI	42	28542,77	-6798,13	-4928,36	914,40	522,93	100,15	34884
CRJ9 CI	43	29066,37	-7098,08	-4500,00	914,40	522,93	101,17	35475
CRJ9 CI	44	29589,97	-7319,08	-4026,06	914,40	522,93	102,18	36057
CRJ9 CI	45	30113,57	-7454,42	-3520,94	914,40	522,93	103,17	36629
CRJ9 CI	46	30637,17	-7500,00	-3000,00	914,40	522,93	104,16	37193
CRJ9 CI	47	31160,77	-7454,42	-2479,06	914,40	522,93	105,14	37748
CRJ9 CI	48	31684,36	-7319,08	-1973,94	914,40	522,93	106,11	38295
CRJ9 CI	49	32207,96	-7098,08	-1500,00	914,40	522,93	107,07	38834
CRJ9 CI	50	32731,56	-6798,13	-1071,64	914,40	522,93	108,03	39366
CRJ9 CI	51	33125,86	-6519,68	-793,18	914,40	393,79	108,74	39762
CRJ9 CI	52	33255,16	-6428,36	-701,87	898,68	130,09	108,66	39724
CRJ9 CI	53	33778,76	-6000,00	-401,92	835,01	526,80	108,33	39567
CRJ9 CI	54	34302,36	-5526,06	-180,92	771,35	526,80	108,00	39410
CRJ9 CI	55	34825,96	-5020,94	-45,58	707,68	526,80	107,67	39252
CRJ9 CI	56	35349,55	-4500,00	0,00	644,02	526,80	107,34	39094
CRJ9 CI	57	37587,58	-2261,98	0,00	371,89	2254,51	105,91	38410
CRJ9 CI	58	37892,38	-1957,18	0,00	334,82	307,04	105,71	44776
CRJ9 CI	59	38486,05	-1363,50	0,00	319,11	593,88	96,71	46010
CRJ9 CI	60	39026,94	-822,62	0,00	304,80	541,08	87,71	47244
CRJ9 CI	61	39677,54	-172,01	0,00	195,53	659,72	87,26	46939
CRJ9 CI	62	39997,85	148,29	0,00	141,73	324,79	87,04	46788
CRJ9 CI	63	40288,97	439,42	0,00	98,10	294,38	86,85	46662
CRJ9 CI	64	40505,85	656,30	0,00	65,59	219,30	86,71	46568
CRJ9 CI	65	40677,79	828,24	0,00	39,82	173,86	86,59	46493
CRJ9 CI	66	40822,38	972,82	0,00	18,16	146,20	86,50	46430
CRJ9 CI	67	40943,52	1093,96	0,00	0,00	122,49	86,42	46378
CRJ9 CI	68	41343,55	1493,99	0,00	0,00	400,03	76,82	47771
CRJ9 CI	69	41696,52	1846,96	0,00	0,00	352,97	67,21	49163
CRJ9 CI	70	42002,43	2152,87	0,00	0,00	305,91	57,61	50556
CRJ9 CI	71	42261,27	2411,72	0,00	0,00	258,84	48,01	51949
CRJ9 CI	72	42473,05	2623,50	0,00	0,00	211,78	38,41	53342
CRJ9 CI	73	42637,77	2788,22	0,00	0,00	164,72	28,81	54735
CRJ9 CI	74	42755,43	2905,87	0,00	0,00	117,66	19,20	56128
CRJ9 CI	75	42826,02	2976,47	0,00	0,00	70,59	9,60	57521
CRJ9 CI	76	42849,55	3000,00	0,00	0,00	23,53	0,00	58914

Table 6.14.1-13: CASE_ID: DH8C AC (Source: Umweltbundesamt [10])

case_ID	segment_ID	sigma (m)	segment_start_x(m)	segment_start_y(m)	segment_start_z(m)	segment_length(m)	True Airspeed (m/s)	NPD_interpolation_thrust(%)
DH8C AC	1	-969,29	969,29	0,00	0,00		15,28	4
DH8C AC	2	-880,55	880,55	0,00	0,00	88,75	24,52	10
DH8C AC	3	-750,56	750,56	0,00	0,00	129,98	33,77	15
DH8C AC	4	-579,34	579,34	0,00	0,00	171,22	43,02	21
DH8C AC	5	-366,89	366,89	0,00	0,00	212,45	52,26	26
DH8C AC	6	-300,01	300,01	0,00	0,00	66,87	55,04	19
DH8C AC	7	28,09	-28,09	0,00	17,20	328,55	55,09	19
DH8C AC	8	419,70	-419,70	0,00	37,72	392,15	55,14	19
DH8C AC	9	885,40	-885,40	0,00	62,12	466,34	55,21	19
DH8C AC	10	1472,81	-1472,81	0,00	92,91	588,22	55,29	19
DH8C AC	11	2261,32	-2261,32	0,00	134,23	789,59	55,40	19
DH8C AC	12	3430,85	-3430,85	0,00	195,53	1171,14	55,57	19
DH8C AC	13	5515,90	-5515,90	0,00	304,80	2087,91	55,86	19
DH8C AC	14	8423,91	-8423,91	0,00	457,20	2912,00	60,96	16
DH8C AC	15	8586,82	-8586,82	0,00	465,74	163,14	61,06	16
DH8C AC	16	18500,00	-18500,00	0,00	985,27	9926,78	66,81	12
DH8C AC	17	19599,56	-19593,98	-95,71	1042,89	1099,67	67,42	12
DH8C AC	18	20699,12	-20654,73	-379,94	1100,52	1099,67	68,02	11
DH8C AC	19	21798,67	-21650,00	-844,04	1158,15	1099,67	68,62	10
DH8C AC	20	22658,89	-22353,76	-1336,82	1203,23	860,31	69,08	10
DH8C AC	21	22898,23	-22549,56	-1473,92	1215,77	239,36	69,21	12
DH8C AC	22	22963,69	-22595,79	-1520,15	1219,20	65,47	69,24	13
DH8C AC	23	23997,79	-23326,08	-2250,44	1219,20	1032,78	74,74	13
DH8C AC	24	25097,34	-23955,96	-3150,00	1219,20	1098,16	80,17	13
DH8C AC	25	26196,90	-24420,06	-4145,27	1219,20	1098,16	85,26	13
DH8C AC	26	27296,46	-24704,29	-5206,02	1219,20	1098,16	90,06	13
DH8C AC	27	28396,02	-24800,00	-6300,00	1219,20	1098,16	94,62	13
DH8C AC	28	28646,20	-24800,00	-6550,18	1219,20	250,18	95,63	13
DH8C AC	29	28951,00	-24800,00	-6854,98	1219,20	304,80	96,81	30
DH8C AC	30	44191,00	-24800,00	-22094,98	1219,20	15240,00	96,81	30
DH8C AC	31	128396,02	-24800,00	-106300,00	1219,20	84205,02		

Table 6.14.1-14: CASE_ID: DH8C AS (Source: Umweltbundesamt [10])

case_ID	segment_ID	sigma (m)	segment_start_x(m)	segment_start_y(m)	segment_start_z(m)	segment_length(m)	True Airspeed (m/s)	NPD_interpolation_thrust(%)
DH8C AS	1	-969,29	969,29	0,00	0,00		15,28	4
DH8C AS	2	-880,55	880,55	0,00	0,00	88,75	24,52	10
DH8C AS	3	-750,56	750,56	0,00	0,00	129,98	33,77	15
DH8C AS	4	-579,34	579,34	0,00	0,00	171,22	43,02	21
DH8C AS	5	-366,89	366,89	0,00	0,00	212,45	52,26	26
DH8C AS	6	-300,01	300,01	0,00	0,00	66,87	55,04	19
DH8C AS	7	28,09	-28,09	0,00	17,20	328,55	55,09	19
DH8C AS	8	419,70	-419,70	0,00	37,72	392,15	55,14	19
DH8C AS	9	885,40	-885,40	0,00	62,12	466,34	55,21	19
DH8C AS	10	1472,81	-1472,81	0,00	92,91	588,22	55,29	19
DH8C AS	11	2261,32	-2261,32	0,00	134,23	789,59	55,40	19
DH8C AS	12	3430,85	-3430,85	0,00	195,53	1171,14	55,57	19
DH8C AS	13	5515,90	-5515,90	0,00	304,80	2087,91	55,86	19
DH8C AS	14	8423,91	-8423,91	0,00	457,20	2912,00	60,96	16
DH8C AS	15	10552,74	-10552,74	0,00	568,77	2131,75	62,24	16
DH8C AS	16	22658,89	-22658,89	0,00	1203,23	12122,77	69,08	10
DH8C AS	17	22963,69	-22963,69	0,00	1219,20	305,22	69,24	13
DH8C AS	18	24655,74	-24655,74	0,00	1219,20	1692,05	78,03	13
DH8C AS	19	26549,91	-26549,91	0,00	1219,20	1894,17	86,83	13
DH8C AS	20	28646,20	-28646,20	0,00	1219,20	2096,29	95,63	13
DH8C AS	21	28951,00	-28951,00	0,00	1219,20	304,80	96,81	30
DH8C AS	22	44191,00	-44191,00	0,00	1219,20	15240,00	96,81	30
DH8C AS	23	98500,00	-98500,00	0,00	1219,20	54309,00		

Table 6.14.1-15: CASE_ID: DH8C DC (Source: Umweltbundesamt [10])

case_ID	segment_ID	sigma (m)	segment_start_x(m)	segment_start_y(m)	segment_start_z(m)	segment_length(m)	True Airspeed (m/s)	NPD_interpolation_thrust(%)
DH8C DC	1	0,00	0,00	0,00	0,00	23,41	0,00	151
DH8C DC	2	23,41	23,41	0,00	0,00	70,24	9,54	142
DH8C DC	3	93,65	93,65	0,00	0,00	117,06	19,08	132
DH8C DC	4	210,72	210,72	0,00	0,00	163,89	28,63	123
DH8C DC	5	374,61	374,61	0,00	0,00	210,72	38,17	114
DH8C DC	6	585,32	585,32	0,00	0,00	257,54	47,71	104
DH8C DC	7	842,86	842,86	0,00	0,00	111,92	57,25	95
DH8C DC	8	953,46	953,46	0,00	17,20	133,59	57,30	95
DH8C DC	9	1085,46	1085,46	0,00	37,72	158,86	57,36	95
DH8C DC	10	1242,43	1242,43	0,00	62,12	200,38	57,42	96
DH8C DC	11	1440,43	1440,43	0,00	92,91	268,98	57,50	96
DH8C DC	12	1706,22	1706,22	0,00	134,23	398,95	57,62	96
DH8C DC	13	2100,43	2100,43	0,00	195,53	711,26	57,78	96
DH8C DC	14	2803,25	2803,25	0,00	304,80	690,89	58,08	97
DH8C DC	15	3490,36	3490,36	0,00	377,01	210,18	63,32	93
DH8C DC	16	3700,00	3700,00	0,00	392,02	95,28	64,96	87
DH8C DC	17	3795,16	3794,67	-8,28	398,83	785,08	65,69	84
DH8C DC	18	4579,22	4574,77	-76,53	454,91	221,41	71,40	77
DH8C DC	19	4799,56	4793,98	-95,71	479,36	1104,92	71,48	77
DH8C DC	20	5899,11	5854,73	-379,94	601,37	1104,92	71,91	78
DH8C DC	21	6998,67	6850,00	-844,04	723,37	1104,92	72,33	79
DH8C DC	22	8098,23	7749,56	-1473,92	845,38	625,07	72,76	80
DH8C DC	23	8720,27	8188,85	-1913,21	914,40	477,70	72,99	80
DH8C DC	24	9197,79	8526,08	-2250,44	941,83	1099,98	75,16	79
DH8C DC	25	10297,34	9155,96	-3150,00	1005,00	1099,98	79,93	76
DH8C DC	26	11396,90	9620,06	-4145,27	1068,17	1099,98	84,43	73
DH8C DC	27	12496,46	9904,29	-5206,02	1131,33	1099,98	88,71	70
DH8C DC	28	13596,02	10000,00	-6300,00	1194,50	1195,40	92,78	67
DH8C DC	29	14789,44	10000,00	-7493,43	1263,06	397,29	97,02	63
DH8C DC	30	15185,84	10000,00	-7889,83	1289,61	5788,22	97,15	64
DH8C DC	31	20961,13	10000,00	-13665,11	1676,40	9428,96	99,02	66
DH8C DC	32	30370,36	10000,00	-23074,35	2286,00	12445,29	102,11	70
DH8C DC	33	42792,30	10000,00	-35496,29	3048,00	70936,80	106,12	74
DH8C DC	34	113596,02	10000,00	-106300,00	7391,32			

Table 6.14.1-16: CASE_ID: DH8C DS (Source: Umweltbundesamt [10])

case_ID	segment_ID	sigma (m)	segment_start_x(m)	segment_start_y(m)	segment_start_z(m)	segment_length(m)	True Airspeed (m/s)	NPD_interpolation_thrust(%)
DH8C DS	1	0,00	0,00	0,00	0,00	23,41	0,00	151
DH8C DS	2	23,41	23,41	0,00	0,00	70,24	9,54	142
DH8C DS	3	93,65	93,65	0,00	0,00	117,06	19,08	132
DH8C DS	4	210,72	210,72	0,00	0,00	163,89	28,63	123
DH8C DS	5	374,61	374,61	0,00	0,00	210,72	38,17	114
DH8C DS	6	585,32	585,32	0,00	0,00	257,54	47,71	104
DH8C DS	7	842,86	842,86	0,00	0,00	111,92	57,25	95
DH8C DS	8	953,46	953,46	0,00	17,20	133,59	57,30	95
DH8C DS	9	1085,46	1085,46	0,00	37,72	158,86	57,36	95
DH8C DS	10	1242,43	1242,43	0,00	62,12	200,38	57,42	96
DH8C DS	11	1440,43	1440,43	0,00	92,91	268,98	57,50	96
DH8C DS	12	1706,22	1706,22	0,00	134,23	398,95	57,62	96
DH8C DS	13	2100,43	2100,43	0,00	195,53	711,26	57,78	96
DH8C DS	14	2803,25	2803,25	0,00	304,80	690,89	58,08	97
DH8C DS	15	3490,36	3490,36	0,00	377,01	305,58	63,32	93
DH8C DS	16	3795,16	3795,16	0,00	398,83	786,07	65,69	84
DH8C DS	17	4579,22	4579,22	0,00	454,91	431,16	71,40	77
DH8C DS	18	5007,75	5007,75	0,00	502,46	3735,30	71,57	78
DH8C DS	19	8720,27	8720,27	0,00	914,40	1835,51	72,99	80
DH8C DS	20	10552,75	10552,75	0,00	1019,67	2026,39	81,00	74
DH8C DS	21	12575,81	12575,81	0,00	1135,89	2217,28	89,01	69
DH8C DS	22	14789,44	14789,44	0,00	1263,06	397,29	97,02	63
DH8C DS	23	15185,84	15185,84	0,00	1289,61	5788,22	97,15	64
DH8C DS	24	20961,13	20961,13	0,00	1676,40	9428,96	99,02	66
DH8C DS	25	30370,36	30370,36	0,00	2286,00	12445,29	102,11	70
DH8C DS	26	42792,30	42792,30	0,00	3048,00	58818,05	106,12	74
DH8C DS	27	101500,00	101500,00	0,00	6649,31			

Table 6.14.1-17: CASE_ID: DH8C CI (1) (Source: Umweltbundesamt [10])

case_ID	segment_ID	sigma (m)	segment_start_x(m)	segment_start_y(m)	segment_start_z(m)	segment_length(m)	True Airspeed (m/s)	NPD_interpolation_thrust(%)
DH8C CI	1	-969,29	2030,71	0,00	0,00		15,28	4
DH8C CI	2	-880,55	2119,45	0,00	0,00	88,75	24,52	10
DH8C CI	3	-750,56	2249,44	0,00	0,00	129,98	33,77	15
DH8C CI	4	-579,34	2420,66	0,00	0,00	171,22	43,02	21
DH8C CI	5	-366,89	2633,11	0,00	0,00	212,45	52,26	26
DH8C CI	6	-300,01	2699,99	0,00	0,00	66,87	55,04	19
DH8C CI	7	122,11	3122,11	0,00	22,12	422,71	55,10	19
DH8C CI	8	625,95	3625,95	0,00	48,53	504,52	55,17	19
DH8C CI	9	1225,10	4225,10	0,00	79,93	599,97	55,26	19
DH8C CI	10	1980,84	4980,84	0,00	119,53	756,78	55,37	19
DH8C CI	11	2995,31	5995,31	0,00	172,70	1015,86	55,51	19
DH8C CI	12	4500,00	7500,00	0,00	251,56	1506,75	55,72	19
DH8C CI	13	5023,60	8020,94	-45,58	279,00	523,65	55,79	19
DH8C CI	14	5515,90	8495,87	-172,83	304,80	492,36	55,86	19
DH8C CI	15	5547,20	8526,06	-180,92	306,44	31,30	55,92	19
DH8C CI	16	6070,80	9000,00	-401,92	333,88	523,65	56,87	19
DH8C CI	17	6594,40	9428,36	-701,87	361,32	523,65	57,80	18
DH8C CI	18	7117,99	9798,13	-1071,64	388,76	523,65	58,72	18
DH8C CI	19	7641,59	10098,08	-1500,00	416,20	523,65	59,63	17
DH8C CI	20	8165,19	10319,08	-1973,94	443,64	523,65	60,52	17
DH8C CI	21	8423,91	10385,95	-2223,53	457,20	258,75	60,96	16
DH8C CI	22	8688,79	10454,42	-2479,06	471,08	264,91	61,12	16
DH8C CI	23	9212,39	10500,00	-3000,00	498,52	523,65	61,43	16
DH8C CI	24	9735,99	10454,42	-3520,94	525,96	523,65	61,75	16
DH8C CI	25	10259,59	10319,08	-4026,06	553,40	523,65	62,06	16
DH8C CI	26	10783,19	10098,08	-4500,00	580,85	523,65	62,38	16
DH8C CI	27	11306,78	9798,13	-4928,36	608,29	523,65	62,69	15
DH8C CI	28	11830,38	9428,36	-5298,13	635,73	523,65	63,00	15
DH8C CI	29	12353,98	9000,00	-5598,08	663,17	523,65	63,30	15
DH8C CI	30	12877,58	8526,06	-5819,08	690,61	523,65	63,61	15
DH8C CI	31	13401,18	8020,94	-5954,42	718,05	523,65	63,92	14
DH8C CI	32	13924,78	7500,00	-6000,00	745,49	523,65	64,22	14
DH8C CI	33	17147,75	4277,03	-6000,00	914,40	3227,40	66,06	13
DH8C CI	34	25924,78	-4500,00	-6000,00	914,40	8777,03	69,73	58
DH8C CI	35	26448,38	-5020,94	-5954,42	914,40	522,93	69,94	60

Table 6.14.1-18: CASE_ID: DH8C CI (2) (Source: Umweltbundesamt [10])

case_ID	segment_ID	sigma (m)	segment_start_x(m)	segment_start_y(m)	segment_start_z(m)	segment_length(m)	True Airspeed (m/s)	NPD_interpolation_thrust(%)
DH8C CI	36	26971,97	-5526,06	-5819,08	914,40	522,93	70,15	61
DH8C CI	37	27495,57	-6000,00	-5598,08	914,40	522,93	70,36	63
DH8C CI	38	28019,17	-6428,36	-5298,13	914,40	522,93	70,58	65
DH8C CI	39	28542,77	-6798,13	-4928,36	914,40	522,93	70,79	66
DH8C CI	40	29066,37	-7098,08	-4500,00	914,40	522,93	71,00	67
DH8C CI	41	29589,97	-7319,08	-4026,06	914,40	522,93	71,21	69
DH8C CI	42	30113,57	-7454,42	-3520,94	914,40	522,93	71,41	70
DH8C CI	43	30637,17	-7500,00	-3000,00	914,40	522,93	71,62	72
DH8C CI	44	31160,77	-7454,42	-2479,06	914,40	522,93	71,83	73
DH8C CI	45	31684,36	-7319,08	-1973,94	914,40	522,93	72,04	74
DH8C CI	46	32207,96	-7098,08	-1500,00	914,40	522,93	72,24	76
DH8C CI	47	32731,56	-6798,13	-1071,64	914,40	522,93	72,45	77
DH8C CI	48	33255,16	-6428,36	-701,87	914,40	522,93	72,65	78
DH8C CI	49	33778,76	-6000,00	-401,92	914,40	522,93	72,86	79
DH8C CI	50	34129,29	-5682,72	-253,97	914,40	350,08	72,99	80
DH8C CI	51	34302,36	-5526,06	-180,92	895,20	173,91	72,93	80
DH8C CI	52	34825,96	-5020,94	-45,58	837,10	526,15	72,73	80
DH8C CI	53	35349,55	-4500,00	0,00	779,00	526,15	72,53	79
DH8C CI	54	38270,33	-1579,22	0,00	454,91	2938,70	71,40	77
DH8C CI	55	39054,40	-795,16	0,00	398,83	786,07	65,69	84
DH8C CI	56	39359,20	-490,36	0,00	377,01	305,58	63,32	93
DH8C CI	57	40046,31	196,76	0,00	304,80	690,90	58,08	97
DH8C CI	58	40749,12	899,57	0,00	195,53	711,26	57,78	96
DH8C CI	59	41143,34	1293,79	0,00	134,23	398,95	57,62	96
DH8C CI	60	41409,12	1559,57	0,00	92,91	268,98	57,50	96
DH8C CI	61	41607,12	1757,57	0,00	62,12	200,38	57,42	96
DH8C CI	62	41764,10	1914,54	0,00	37,72	158,86	57,36	95
DH8C CI	63	41896,10	2046,54	0,00	17,20	133,59	57,30	95
DH8C CI	64	42006,69	2157,14	0,00	0,00	111,92	57,25	95
DH8C CI	65	42264,23	2414,68	0,00	0,00	257,54	47,71	104
DH8C CI	66	42474,95	2625,39	0,00	0,00	210,72	38,17	114
DH8C CI	67	42638,84	2789,28	0,00	0,00	163,89	28,63	123
DH8C CI	68	42755,90	2906,35	0,00	0,00	117,06	19,08	132
DH8C CI	69	42826,14	2976,59	0,00	0,00	70,24	9,54	142
DH8C CI	70	42849,55	3000,00	0,00	0,00	23,41	0,00	151

6.14.2 Appendix B (normative)

Table 6.14.2-1: CASE_ID: A320 DS / IP05 (Source: Umweltbundesamt [10])

case_ID	receptor_ID	segment_ID	Lmax_noise_fraction	baseline_SEL(dB)	acoustic_impedance_adjustment(dB)	speed_corr(dB)	engine_Install_correction(dB)	lateral_attenuation(dB)	noise_fraction	start_of_roll_correction(dB)	segment_SEL(dB)
A320 DS	R05	1	82,72	92,32	0,07	12,48	-1,50	8,82	-47,32	0,00	47,23
A320 DS	R05	2	82,34	92,00	0,07	7,71	-1,50	8,82	-42,12	0,00	47,35
A320 DS	R05	3	81,96	91,68	0,07	5,49	-1,50	8,82	-39,20	0,00	47,73
A320 DS	R05	4	81,58	91,36	0,07	4,03	-1,50	8,82	-36,74	0,00	48,4
A320 DS	R05	5	81,20	91,04	0,07	2,94	-1,50	8,82	-34,33	0,00	49,41
A320 DS	R05	6	80,82	90,73	0,07	2,07	-1,50	8,82	-31,74	0,00	50,81
A320 DS	R05	7	80,44	90,41	0,07	1,34	-1,50	8,82	-28,79	0,00	52,71
A320 DS	R05	8	80,06	90,09	0,07	0,72	-1,50	8,82	-25,28	0,00	55,28
A320 DS	R05	9	79,68	89,77	0,07	0,18	-1,50	8,82	-20,90	0,00	58,79
A320 DS	R05	10	78,92	89,28	0,07	-0,08	-0,31	6,84	-22,93	0,00	59,21
A320 DS	R05	11	78,94	89,30	0,07	-0,08	-0,31	5,09	-20,66	0,00	63,23
A320 DS	R05	12	78,96	89,32	0,07	-0,09	-0,31	3,64	-18,00	0,00	67,36
A320 DS	R05	13	78,99	89,34	0,07	-0,09	-0,31	2,46	-14,46	0,00	72,09
A320 DS	R05	14	79,02	89,37	0,07	-0,1	-0,31	1,55	-9,75	0,00	77,74
A320 DS	R05	15	79,07	89,41	0,07	-0,11	-0,31	0,94	-4,43	0,00	83,69
A320 DS	R05	16	79,07	89,41	0,07	-0,11	-0,31	0,89	-4,05	0,00	84,12
A320 DS	R05	17	78,47	89,05	0,07	-0,14	-0,01	0,43	-12,66	0,00	75,88
A320 DS	R05	18	78,18	88,80	0,07	-0,54	-0,01	0,35	-20,02	0,00	67,96
A320 DS	R05	19	77,88	88,55	0,07	-0,91	-0,01	0,28	-25,61	0,00	61,82
A320 DS	R05	20	77,54	88,27	0,07	-1,25	0,01	0,22	-29,87	0,00	57,02
A320 DS	R05	21	78,70	88,96	0,07	-1,57	-1,08	0,15	-39,01	0,00	47,22
A320 DS	R05	22	74,07	84,86	0,07	-1,57	-1,08	0,11	-41,71	0,00	40,46
A320 DS	R05	23	74,09	84,88	0,07	-1,58	-1,08	0,09	-32,61	0,00	49,59
A320 DS	R05	24	69,11	81,53	0,07	-1,66	0,40	0,00	-40,65	0,00	39,69
A320 DS	R05	25	69,11	81,52	0,07	-1,89	0,40	0,00	-42,46	0,00	37,65
A320 DS	R05	26	74,74	85,44	0,07	-2,11	-1,50	0,00	-46,41	0,00	35,49
A320 DS	R05	27	75,08	85,75	0,07	-2,17	-1,50	0,00	-49,79	0,00	32,35
A320 DS	R05	28	75,43	86,08	0,07	-2,25	-0,95	0,00	-52,55	0,00	30,4
A320 DS	R05	29	74,73	85,74	0,07	-2,39	-0,04	0,00	-55,69	0,00	27,7
A320 DS	R05	30	75,25	86,21	0,07	-2,56	-0,04	0,00	-58,06	0,00	25,63
A320 DS	R05	31									

6.14.3 Appendix C (normative)

Table 6.14.3-1: CASE_ID: A320 DS /IP05 (Source: Umweltbundesamt [10])

case_ID	receptor_ID	segment_ID	slant_distance(m)	distance_d1(m)	distance_d2(m)	distance_q(m)	lateral_displacement(m)	NPD_interpolation_distance(m)	NPD_interpolation_thrust(N)	angle_beta(°)	angle_gamma(°)	angle_phi(°)	bank_angle(°)
A320 DS	R05	1	500,00	3041,38	3019,31	3000,00	500,00	500,00	110076,04	0,00	0,00	0,00	0,00
A320 DS	R05	2	500,00	3019,31	2953,14	2977,63	500,00	500,00	108028,38	0,00	0,00	0,00	0,00
A320 DS	R05	3	500,00	2953,14	2842,95	2910,51	500,00	500,00	105980,71	0,00	0,00	0,00	0,00
A320 DS	R05	4	500,00	2842,95	2688,92	2798,64	500,00	500,00	103933,05	0,00	0,00	0,00	0,00
A320 DS	R05	5	500,00	2688,92	2491,35	2642,02	500,00	500,00	101885,39	0,00	0,00	0,00	0,00
A320 DS	R05	6	500,00	2491,35	2250,79	2440,66	500,00	500,00	99837,72	0,00	0,00	0,00	0,00
A320 DS	R05	7	500,00	2250,79	1968,27	2194,56	500,00	500,00	97790,05	0,00	0,00	0,00	0,00
A320 DS	R05	8	500,00	1968,27	1645,88	1903,70	500,00	500,00	95742,40	0,00	0,00	0,00	0,00
A320 DS	R05	9	500,00	1645,88	1288,70	1568,10	500,00	500,00	93694,73	0,00	0,00	0,00	0,00
A320 DS	R05	10	535,18	1288,70	1192,18	1172,32	500,00	535,18	91647,06	2,00	9,25	20,89	0,00
A320 DS	R05	11	535,18	1192,18	1079,57	1065,30	500,00	535,18	91726,28	4,37	9,25	20,89	0,00
A320 DS	R05	12	535,18	1079,57	950,64	937,57	500,00	535,18	91820,73	7,17	9,25	20,89	0,00
A320 DS	R05	13	535,18	950,64	799,60	785,68	500,00	535,18	91932,93	10,66	9,25	20,89	0,00
A320 DS	R05	14	535,18	799,60	632,40	594,09	500,00	535,18	92074,26	15,22	9,25	20,89	0,00
A320 DS	R05	15	535,18	632,40	537,04	336,90	500,00	535,18	92263,63	20,89	9,25	20,89	0,00
A320 DS	R05	16	535,18	537,04	900,84	-44,56	500,00	535,18	92543,79	21,61	9,25	20,89	0,00
A320 DS	R05	17	568,85	900,84	1494,14	-698,51	500,00	568,85	93041,17	31,40	2,78	28,48	0,00
A320 DS	R05	18	568,85	1494,14	2202,83	-1381,62	500,00	568,85	91461,16	34,08	2,78	28,48	0,00
A320 DS	R05	19	568,85	2202,83	2992,57	-2128,11	500,00	568,85	89881,15	36,83	2,78	28,48	0,00
A320 DS	R05	20	571,29	2992,57	3889,08	-2937,53	500,00	571,29	88301,13	39,61	2,68	28,93	0,00
A320 DS	R05	21	503,17	3889,08	4193,14	-3856,39	500,00	503,17	86754,18	42,51	5,95	6,44	0,00
A320 DS	R05	22	503,20	4193,14	4336,02	-4162,84	500,00	503,20	67774,02	44,43	5,95	6,46	0,00
A320 DS	R05	23	503,20	4336,02	8298,65	-4306,72	500,00	503,20	67862,89	45,30	5,95	6,46	0,00
A320 DS	R05	24	796,98	8298,65	9366,34	-8260,29	500,00	796,98	70274,67	61,35	2,04	51,14	0,00
A320 DS	R05	25	796,98	9366,34	10491,04	-9332,37	500,00	796,98	70260,10	62,32	2,04	51,14	0,00
A320 DS	R05	26	501,28	10491,04	13513,29	-10479,06	500,00	501,28	70245,53	63,38	5,63	0,00	0,00
A320 DS	R05	27	501,28	13513,29	17452,71	-13503,99	500,00	501,28	71615,16	68,90	5,63	0,00	0,00
A320 DS	R05	28	505,39	17452,71	24084,51	-17445,39	500,00	505,39	73361,45	73,46	5,27	8,37	0,00
A320 DS	R05	29	564,43	24084,51	33142,89	-24077,90	500,00	564,43	75596,80	77,70	4,82	27,64	0,00
A320 DS	R05	30	564,43	33142,89	98873,94	-33138,08	500,00	564,43	77670,82	80,72	4,82	27,64	0,00
A320 DS	R05	31											

7 Test scenarios for BEB, determination of the impact on affected persons

7.1 Purpose

This set of test cases includes the analysis of the exposure to environmental noise according to the calculation method for determining the number of exposure to environmental noise (BEB) [4].

7.2 Preliminary remarks

The load analysis derives an accuracy requirement of ±10 %.

7.3 Test Cases

7.3.1 TC_B 1: Resident distribution of a known total number of residents across 5 buildings with different heights and floor areas

Input data

- 25 residents

Table 7.3.1-1: Geometry (Source: Umweltbundesamt [9])

Building	X	Y	Z		Building	X	Y	Z
House A	20	186	3		House B	20	170	4
	29	186	3			32	170	4
	29	173	3			32	150	4
	20	173	3			20	150	4
House C	20	146	5		House D	20	132	6
	30	146	5			32	132	6
	30	136	5			32	120	6
	20	136	5			20	120	6
House E	20	116	7		Premises			0
	32	116	7					
	32	96	7					
	20	96	7					

Results

The following distribution of residents results from the geometrical data of the buildings.

Table 7.3.1-2: Distribution of residents (Source: Umweltbundesamt [9])

Building	Building floor area [m²]	Building volume [m³]	Residents
House A	117	351	2.015
House B	240	960	5.511
House C	100	500	2.870
House D	144	864	4.960
House E	240	1,680	9.644
Sum		4,355	25

7.3.2 TC_B 2: Determination of occupants across 5 buildings with different heights and floor areas from living space per occupant

Input data

- 38 m^2 living space per resident
- Floor height 3 m

Table 7.3.2-1: Geometry (Source: Umweltbundesamt [9])

Building	X	Y	Z		Building	X	Y	Z
House A	20	186	3		House B	20	170	4
	29	186	3			32	170	4
	29	173	3			32	150	4
	20	173	3			20	150	4
House C	20	146	5		House D	20	132	6
	30	146	5			32	132	6
	30	136	5			32	120	6
	20	136	5			20	120	6
House E	20	116	7		Premises			0
	32	116	7					
	32	96	7					
	20	96	7					

Results

The following distribution of the inhabitants results from the geometry data of the buildings.

Table 7.3.2-2: Distribution of residents (Source: Umweltbundesamt [9])

Building	Building floor area [m^2]	Height	Number of floors	Residents
House A	117	3	1.000	2.463
House B	240	4	1.336	6.737
House C	100	5	1.667	3.509
House D	144	6	2.000	6.063
House E	240	7	2.333	11.789
Sum				30.561

7.3.3 TC_B 3: Position determination of facade points with simple building geometry with allocation of the number of affected persons from known number of residents per building

Input data

Table 7.3.3-1: Geometry (Source: Umweltbundesamt [9])

Building	X	Y	Z		Building	X	Y	Z
House A 3 residents	20	186	3		House B 15 residents	20	168	9
	29	186	3			32	168	9
	29	173	3			32	150	9
	20	173	3			20	150	9
House C 4 residents	20	146	6		Premises			0
	28	146	6					
	28	135	6					
	20	135	6					

Results

This results in the following facade points and number of residents.

Table 7.3.3-2: Distribution of residents across facade points (Source: Umweltbundesamt [9])

Building	X	Y	Z	length	Residents
House A	22.25	186.00	2.8	4.50	0.307
	26.75	186.00	2.8	4.50	0.307
	29.00	183.83	2.8	4.33	0.295
	29.00	179.50	2.8	4.33	0.295
	29.00	175.17	2.8	4.33	0.295
	26.75	173.00	2.8	4.50	0.307
	22.25	173.00	2.8	4.50	0.307
	20.00	175.17	2.8	4.33	0.295
	20.00	179.50	2.8	4.33	0.295
	20.00	183.83	2.8	4.33	0.295
	Sum			44.00	3.000
House B	22.00	168.00	4.0	4.00	1.000
	26.00	168.00	4.0	4.00	1.000
	30.00	168.00	4.0	4.00	1.000
	32.00	165.75	4.0	4.50	1.125
	32.00	161.25	4.0	4.50	1.125
	32.00	156.75	4.0	4.50	1.125
	32.00	152.25	4.0	4.50	1.125
	30.00	150.00	4.0	4.00	1.000
	26.00	150.00	4.0	4.00	1.000
	22.00	150.00	4.0	4.00	1.000
	20.00	152.25	4.0	4.50	1.125
	20.00	156.75	4.0	4.50	1.125
	20.00	161.25	4.0	4.50	1.125
	20.00	165.75	4.0	4.50	1.125
	Sum			60.00	15.000
House C	22.00	146.00	4.0	4.00	0.421
	26.00	146.00	4.0	4.00	0.421
	28.00	144.17	4.0	3.67	0.386
	28.00	140.50	4.0	3.67	0.386
	28.00	136.83	4.0	3.67	0.386
	26.00	135.00	4.0	4.00	0.421
	22.00	135.00	4.0	4.00	0.421
	20.00	136.83	4.0	3.67	0.386
	20.00	140.50	4.0	3.67	0.386
	20.00	144.17	4.0	3.67	0.386
	Sum			40.00	4.000

7.3.4 TC_B 4: Position determination of facade points with complex building geometry (several bay windows and extensions, building heights also under 4 m) with allocation of the number of affected persons from known number of residents per building

Input data

- House A: 5 residents
- House B: 2 residents

Table 7.3.4-1: Geometry (Source: Umweltbundesamt [9])

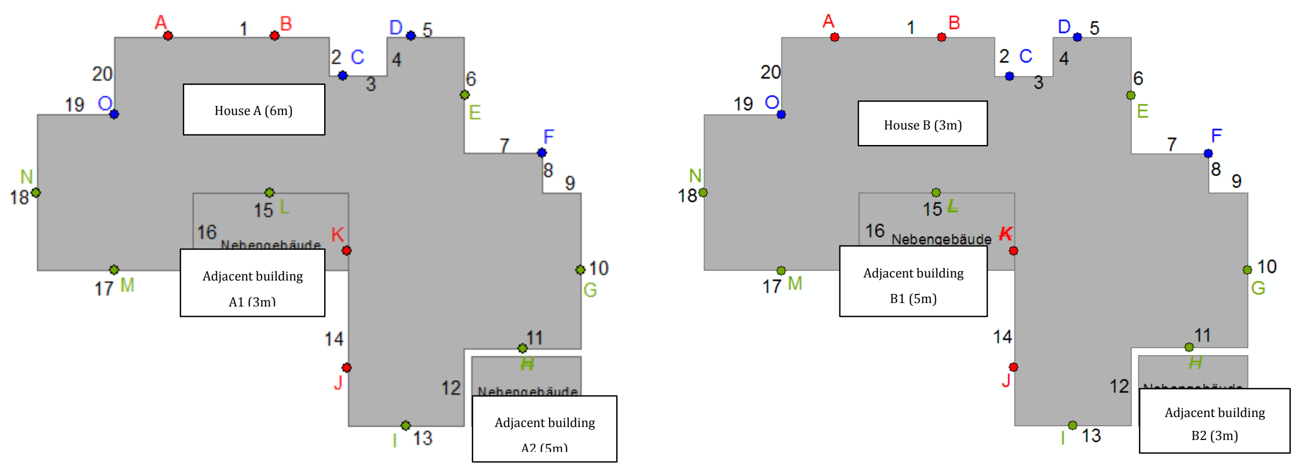
Building	X	Y	Z		Building	X	Y	Z
House A	5	196	6		House B	5	182	3
5 residents	10.5	196	6		2 residents	10.5	182	3
	10.5	195	6			10.5	181	3
	12	195	6			12	181	3
	12	196	6			12	182	3
	14	196	6			14	182	3
	14	193	6			14	179	3
	16	193	6			16	179	3
	16	192	6			16	178	3
	17	192	6			17	178	3
	17	188	6			17	174	3
	14	188	6			14	174	3
	14	186	6			14	172	3
	11	186	6			11	172	3
	11	192	6			11	178	3
	7	192	6			7	178	3
	7	190	6			7	176	3
	3	190	6			3	176	3
	3	194	6			3	180	3
	5	194	6			5	180	3
Adjacent building A1	7	190	3		Adjacent building B1	7	176	5
no residents	11	190	3		no residents	11	176	5
	11	192	3			11	178	5
	7	192	3			7	178	5
Adjacent building A2	14.2	186	5		Adjacent building B2	14.2	172	3
no residents	17	186	5		no residents	17	172	3
	17	187.8	5			17	173.8	3
	14.2	187.8	5			14.2	173.8	3

Results

Facade points are only set for buildings with residents, even if they are not 4 m high. For buildings with a height of less than 4.2 m, the immission points must be placed 0.2 m below the upper edge of the building.

If a building under consideration abuts another building, facade points that would be located in this building are omitted. A tolerance due to inaccurate position/digitization must be provided. However, if these facade points lie above the other building, they must be calculated. The procedure is described below (see Figure7.3.4-1):

Figure7.3.4-1: Facade sections and facade points (Source: Umweltbundesamt [9])



a. Facade sections of more than 5 m are divided so that as few sections as possible are created and each section represents a maximum of 5 m.
Sections 1 and 14 are divided and the facade points ***A, B, J*** *and* ***K*** *are defined.*

b. Remaining facade sections with a length of more than 2.5 m (up to 5 m) are represented by a dot.
*This concerns the sections (facade points) 6 (**E**), 10 (**G**), 11 (**H**), 13 (**I**), 15 (**L**), 17 (**M**) and 18 (**N**).*

c. Remaining, successive facade sections of less than 2.5 m each are combined. If they are longer than 2.5 m together, they are treated as in steps a and b.
*Sections 2 through 5 together are longer than 5 m (a) and are represented by points **C** and **D**. Sections 7 to 9 together are longer than 2.5 m (b) are represented by point **F**, sections 19 and 20 by point **O**.*

d. Sections 12 and 16 are each shorter than 2.5 m and are not connected to other short sections. No points are calculated here.

e. Facade points that are located in another building (with a tolerance of 1 m) are removed. In the case of House A, this concerns point **H,** and in the case of House B, points **H**, **K** and **L**.

f. For each facade point, the length of the facade that it represents is determined. The residents are distributed proportionally across the facade sections represented by facade points.

Table 7.3.4-2: Distribution of residents across facade points (Source: Umweltbundesamt [9])

Building	FP	X	Y	Z	length	Residents
House A	A	6.38	196.00	4.0	2.75	0.293
	B	9.13	196.00	4.0	2.75	0.293
	C	10.88	195.00	4.0	2.75	0.293
	D	12.63	196.00	4.0	2.75	0.293
	E	14.00	194.50	4.0	3.00	0.319
	F	16.00	193.00	4.0	4.00	0.426
	G	17.00	190.00	4.0	4.00	0.426
	H	not applicable				
	I	12.50	186.00	4.0	3.00	0.319
	J	11.00	187.50	4.0	3.00	0.319
	K	11.00	190.50	4.0	3.00	0.319
	L	9.00	192.00	4.0	4.00	0.426
	M	5.00	190.00	4.0	4.00	0.426
	N	3.00	192.00	4.0	4.00	0.426
	O	5.00	194.00	4.0	4.00	0.426
	Sum				47.00	5.000
House B	A	6.38	196.00	2.8	2.75	0.138
	B	9.13	196.00	2.8	2.75	0.138
	C	10.88	195.00	2.8	2.75	0.138
	D	12.63	196.00	2.8	2.75	0.138
	E	14.00	194.50	2.8	3.00	0.150
	F	16.00	193.00	2.8	4.00	0.200
	G	17.00	190.00	2.8	4.00	0.200
	H	not applicable				
	I	12.50	186.00	2.8	3.00	0.150
	J	11.00	187.50	2.8	3.00	0.150
	K	not applicable				
	L	not applicable				
	M	5.00	190.00	2.8	4.00	0.200
	N	3.00	192.00	2.8	4.00	0.200
	O	5.00	194.00	2.8	4.00	0.200
	Sum				40.00	2.000

7.3.5 TC_B 5: Determination of the classification from calculated facade points for a school with several buildings

Input data

- 5 School buildings (A to E)
- 3 Hospital buildings (A to C)

Table 7.3.5-1: Facade level in dB(A) (Source: Umweltbundesamt [9])

School building A - L_{DEN} facade level in dB(A)										
49.21	49.93	66.80	45.76	52.50	55.38	45.75	50.85	75.46	75.91	51.86
49.14	48.40	65.12	46.08	52.59	56.37	44.73	51.75	75.32	75.90	52.33
49.64	48.20	63.76	47.25	52.76	52.12	45.31	69.24	75.11	75.88	52.34
50.05	47.75	54.87	47.37	52.95	52.23	48.15	70.79	74.83	75.85	52.41
50.46	47.07	50.01	47.32	53.22	55.23	48.20	72.25	74.43	75.82	52.46
60.21	46.12	49.51	47.23	53.05	52.61	47.93	75.92	57.66	75.78	52.34
59.41	45.45	49.17	47.14	52.75	52.47	46.87	48.11	56.81	75.73	51.98
58.74	45.61	46.04	57.74	52.00	52.44	45.80	57.75	57.29	75.67	56.79
58.21	75.58	53.93								
School building B - L_{DEN} facade level in dB(A)										
49.05	48.52	57.21	47.17	47.21	47.13	46.41	44.06	47.63	48.91	42.39
49.21	48.76	54.28	42.42	47.56	47.22	45.42	45.71	48.01	49.45	46.85
49.12	48.81	48.45	42.38	47.32	50.29	44.49	48.90	48.44		
School building C - L_{DEN} facade level in dB(A)										
45.48	45.67	45.89	45.90	43.43	43.68	43.61	43.49	43.37	43.49	43.52
43.52	52.14	52.40	52.79	53.11	48.02	47.21	46.99	47.55	48.90	48.90
48.57	48.10									
School building D - L_{DEN} facade level in dB(A)										
61.09	65.97	72.14	64.90	63.04	47.31	46.75	72.03	75.91	75.94	69.05
60.00	64.02	70.48	66.35	63.40	56.28	47.28	75.88	75.93	75.93	70.50
50.43	62.42	68.97	67.89	63.77	66.91					
School building E - L_{DEN} facade level in dB(A)										
42.24	56.46	60.96	58.46	41.91	55.84	41.98	46.23	47.54	48.97	48.85
42.15	55.98	60.03	57.76	45.69	53.80	41.90	46.17	56.34	48.89	48.43
42.06	55.45	59.21	57.13	45.92	51.88	41.95	55.64	59.22	48.67	48.43
48.80										
School building A - L_{DEN} facade level in dB(A)										
45.23	60.35	79.28	66.89	66.73	83.08	58.73	65.72	57.88	75.60	61.75
56.37	61.76	77.67	66.98	64.33	83.09	45.28	56.32	83.05	77.14	60.35
59.75	59.71	76.28	68.20	61.30	83.09	45.54	67.71	83.07	78.90	58.54
66.27	64.47	74.99	67.90	58.80	83.10	45.48	45.47	74.27	83.03	72.91
66.89	65.41	73.74	66.66	58.01	83.10					
Hospital building B - L_{DEN} facade level in dB(A)										
38.64	58.32	61.49	42.17	37.43	42.43	38.02	42.80	45.94	42.88	44.06
39.03	57.77	60.70	44.21	37.30	38.75	37.84	42.84	52.58	43.80	43.97
39.66	57.26	59.97	44.16	40.86	44.13	37.73	37.52	60.41	44.56	43.48
40.24	56.77	59.33	44.12	42.12	42.49	37.63	43.34	63.22	44.84	58.90
37.91	38.95									
Hospital building C - L_{DEN} facade level in dB(A)										
44.57	43.94	43.27	42.90	38.39	39.14	42.23	61.95	64.73	60.58	40.40
43.21	43.98	44.71	38.46	38.63	39.46	41.87	60.87	65.03	42.62	40.89
42.80	44.00	43.94	38.48	38.90	39.89	42.47	61.12	64.70	42.71	63.26
42.42	44.20	43.21	38.33	43.50	43.62	42.89	64.49	63.27		

Results

On the basis of the sound levels at the facade points mentioned above, the following energetic mean values for the buildings result.

Table 7.3.5-2: Energy averages per building (Source: Umweltbundesamt [9])

Building	Average L_{DEN} [dB(A)]	Sound level range [dB(A)]
School building A	68.21	> 65 – 75
School building B	49.00	< 55
School building C	48.17	< 55
School Building D	70.33	> 65 – 75
School building E	54.39	< 55
Hospital building A	76.33	> 75
Hospital building B	53.95	< 55
Hospital building C	57.18	> 55 – 65

Table 7.3.5-3: Statistics according to VBEB (Source: Umweltbundesamt [9])

	L_{DEN} > 55 dB(A)	L_{DEN} > 65 dB(A)	L_{DEN} > 75 dB(A)
School building	2	2	0
Hospital building	2	1	1