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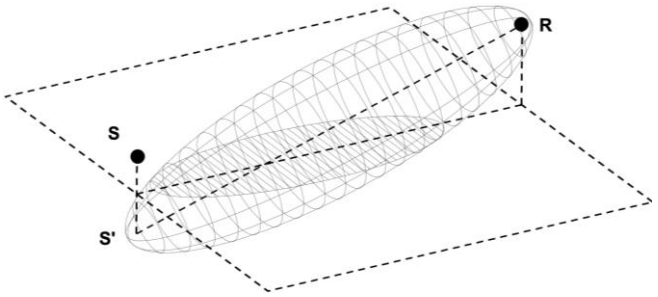

NORD2000

LAFmax levels of the official Nord2000 rail test cases

SUMMARY

The maximum levels that are presented in the most recently published official test cases for Nord2000 rail are only calculated as averages for a train passage, a measure that is rather close to time weighting *S* which is used in Denmark.

Since Swedish limits for maximum level are expressed using time weighting *F* the test cases need to be supplemented with such levels. The work presented in this PM has produced L_{AFmax} results for the current test cases, which can be added to a future updated version of the test case report.

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1 Background

The Nord2000 source model for rail traffic [1] includes a method for calculating the maximum level which is used in Swedish investigations. In Denmark, a simplified version of the method is used instead [2]. The maximum level calculation is based on train emission data that have been measured as sound exposure levels per train passage which are available as average sound power level per meter train. Therefore, it is the average maximum level for a train passage, $\overline{L_{max}}$, that is calculated. The average maximum level is rather close to time weighting *S,* L_{Smax}.

In reality, the emission will vary along the train. One example of such variation is presented in Figure 1, showing L_{AFmax} at distance d = 7,5 m from the center of the track. At such short distance only the closest noise sources will contribute significantly to the measured level, and the maximum level of the passage normally origins from the loudest source of the train, for example the noisiest wheel.

As the distance increases more sources will contribute to the measured level which causes the variations to decrease. The maximum level of the passage will not necessarily origin from the noisiest source anymore but from a group of prominent sources or even the whole train.

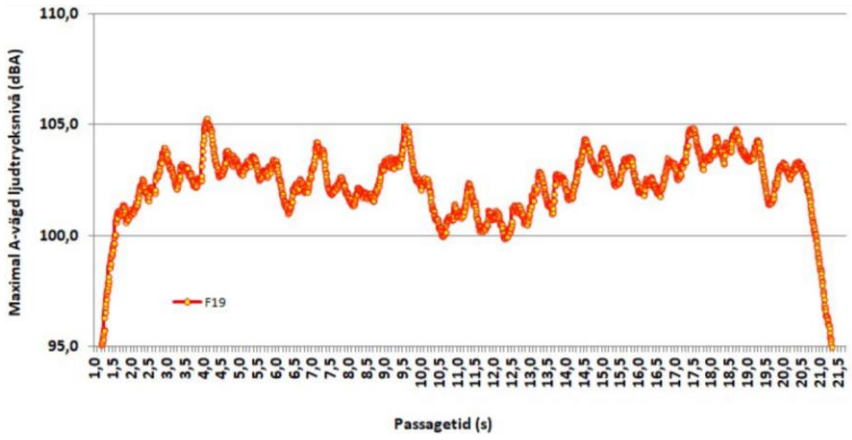

Figure 1. Time series showing A-weighted maximum sound pressure level with time weighting F, L_{AFmax}, during a freight train passage measured 7,5 m from the center of the track [3].

In order to get the maximum level with time average *F*, L_{Fmax}, which is used in Swedish guidelines, the Nord2000 rail source model includes a frequency independent correction for the difference between L_{AFmax} and $\overline{L_{max}}$ that has been derived from measurements of a large number of train passages [4]:

$$L_{Fmax} = \overline{L_{max}} + 3 - 2 \cdot log_{10}\left(\frac{d}{10}\right) \quad (1)$$

An illustration of a typical difference between L_{AFmax} and $\overline{L_{max}}$ is shown in Figure 2.

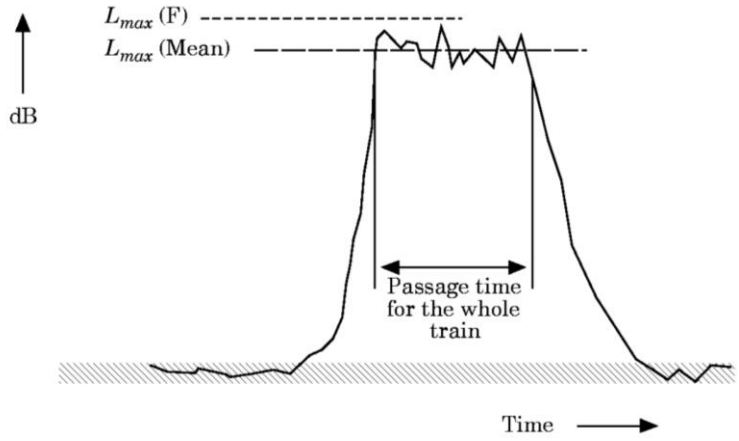

Figure 2. Example of maximum level versus the time signature of a passing train, from [5].

One part of the quality control of an environmental noise calculation software is to make certain that calculated results comply with official test cases (if any). The current test case report for Nord2000 rail traffic calculations was published by the Danish Reference Laboratory in 2018 [6][7]. However, it only presents maximum levels with time weighting *S*. Now that Sweden will be using Nord2000 for railway calculations (recommended method from January 1, 2025) there is a need to update the test cases with L_{AFmax} levels as well.

2 Calculations

The work presented in this PM has produced L_{AFmax} levels for the official test cases which are meant to be included in a future update of the test case report. Calculations have been made according to equation (1), using the values of L_{ASmax} and the distance to railway *d* in [7].

3 Results

The calculated L_{AFmax} results are available in two Excel files, “RailTest_20240807.xlsx” and “RailTestChangeInLW_20240807.xlsx” [8]. The two files correspond to those of [7], with the only difference that L_{AFmax} values have been added.

Two examples from these Excel files are shown below: the case with train type no. 1 and propagation distance 10 m from the Excel file “RailTest_20240807.xlsx”, and the worksheet with L_{AFmax} levels for eight test cases from the Excel file “RailTestChangeInLW_20240807.xlsx”.

Nord2000 - Rail Traffic

Traffic parameters

Train type	1	
l(day)	11000	m per 24h
l(evening)	3000	m per 24h
l(night)	3000	m per 24h
l(max)	300	m
Speed	120	km/h

Propagation parameters

Distance	10	m

Calculated noise levels

Lden	67,70	dB
LpAmaxS	86,97	dB
LpAmaxF	89,97	dB
LpAmax	94,70	dB

Calculated spectra

Freq.	Lden	LpmaxS	LpmaxF
Hz	dB	dB	dB
25	50,18	68,08	71,08
31,5	50,09	67,98	70,98
40	53,24	71,12	74,12
50	58,79	76,64	79,64
63	61,85	79,67	82,67
80	60,95	78,70	81,70
100	58,62	76,27	79,27
125	56,95	74,44	77,44
160	54,70	71,93	74,93
200	57,42	76,51	79,51
250	56,15	75,27	78,27
315	55,40	74,54	77,54
400	54,64	73,81	76,81
500	53,27	72,64	75,64
630	53,59	73,54	76,54
800	56,33	76,43	79,43
1000	58,76	78,47	81,47
1250	59,05	78,16	81,16
1600	58,70	77,76	80,76
2000	58,78	78,04	81,04
2500	56,67	75,56	78,56
3150	54,59	74,31	77,31
4000	52,08	69,88	72,88
5000	49,02	67,88	70,88
6300	45,33	64,84	67,84
8000	43,70	63,19	66,19
10000	42,64	61,12	64,12

Tabell 1. Calculated A-weighted maximum sound levels, L_{AFmax}, for the test case with train type no. 1 and propagation distance 10 m in the Excel file "RailTest_20240807.xlsx.

Nord2000 - Rail Traffic

Change in sound power level along the track
Noise indicator: LpAmaxF (dB)

Distance	d = 10 m				d = 100 m			
along	l(train) = 60 m		l(train) = 300 m		l(train) = 60 m		l(train) = 300 m	
track	l(segm) = 10 m	l(segm) = 100 m	l(segm) = 10 m	l(segm) = 100 m	l(segm) = 10 m	l(segm) = 100 m	l(segm) = 10 m	l(segm) = 100 m
-400	88,64	88,64	89,97	89,97	70,41	70,41	74,87	74,87
-375	88,64	88,64	89,97	89,97	70,41	70,41	74,87	74,87
-350	88,64	88,64	89,97	89,97	70,41	70,41	74,87	74,87
-325	88,64	88,64	89,97	89,97	70,41	70,41	74,87	74,87
-300	88,64	88,64	89,97	89,97	70,41	70,41	74,87	74,87
-275	88,64	88,64	89,97	89,97	70,41	70,41	74,87	74,87
-250	88,64	88,64	89,97	89,97	70,41	70,41	74,87	74,87
-225	88,64	88,64	89,97	89,97	70,41	70,41	74,87	74,87
-200	88,64	88,64	89,97	89,97	70,41	70,41	74,87	74,87
-175	88,64	88,64	89,97	89,97	70,41	70,41	74,87	75,07
-150	88,64	88,64	89,97	89,97	70,41	70,41	74,91	75,38
-125	88,64	88,64	89,97	89,97	70,41	70,41	74,96	75,96
-100	88,64	88,64	89,97	90,00	70,41	70,41	75,11	76,69
-75	88,64	88,70	89,98	90,16	70,41	71,38	75,18	77,67
-50	88,64	92,60	90,00	93,94	70,41	74,37	75,51	78,62
-25	88,80	94,62	90,13	95,93	72,10	76,12	75,62	79,26
0	92,97	94,64	94,97	95,96	72,45	76,41	75,76	79,56
25	88,80	94,62	90,13	95,93	72,10	76,12	75,62	79,26
50	88,64	92,60	90,00	93,94	70,41	74,37	75,51	78,62
75	88,64	88,70	89,98	90,16	70,41	71,38	75,18	77,67
100	88,64	88,64	89,97	90,00	70,41	70,41	75,11	76,69
125	88,64	88,64	89,97	89,97	70,41	70,41	74,96	75,96
150	88,64	88,64	89,97	89,97	70,41	70,41	74,91	75,38
175	88,64	88,64	89,97	89,97	70,41	70,41	74,87	75,07
200	88,64	88,64	89,97	89,97	70,41	70,41	74,87	74,87
225	88,64	88,64	89,97	89,97	70,41	70,41	74,87	74,87
250	88,64	88,64	89,97	89,97	70,41	70,41	74,87	74,87
275	88,64	88,64	89,97	89,97	70,41	70,41	74,87	74,87
300	88,64	88,64	89,97	89,97	70,41	70,41	74,87	74,87
325	88,64	88,64	89,97	89,97	70,41	70,41	74,87	74,87
350	88,64	88,64	89,97	89,97	70,41	70,41	74,87	74,87
375	88,64	88,64	89,97	89,97	70,41	70,41	74,87	74,87
400	88,64	88,64	89,97	89,97	70,41	70,41	74,87	74,87

Tabell 2. Calculated A-weighted maximum sound levels, L_{AFmax}, for the test cases in [6] with a change in sound power level along the track. From Excel file "RailTestChangeInLW_20240807.xlsx".

4 Conclusion

L_{AFmax} levels for the official Nord2000 rail test cases have been calculated and are available in two Excel files. The results are recommended to be included in a future update of the official test case report.

5 References

[1] H. G. Jonasson, S. Å. Storeheier, *Nord 2000. New Nordic Prediction Method for Rail Traffic Noise*. Version 1.0. SP Rapport 2001:11, SP Sveriges Provnings- och Forskningsinstitut, 2001-12-21.

[2] B. Plovsing, *Revision af kildemodel ved anvendelse af Nord2000 til beregning af maksimalværdi fra jernbaner*, RL 14/17, Miljøstyrelsens referencelaboratorium for støymålinger, 27 december 2016.

[3] T. Jerson, *CNOSSOS EU / Nord2000, Mätserie 2 – Grund för indata, Tågbuller, Mätningar av bulleremission från tågpassager vid 7 olika platser på svenska järnvägar*, WSP Environmental Sverige, 2020.

[4] C. Göransson, T. Ström, *Externt buller från svenska tågtyper*, SP Rapport 1994:25, Sveriges Provnings- och Forskningsinstitut, 1995.

[5] *Rail Traffic Noise – Nordic Prediction Method*, TemaNord 1996:524, Nordic Council of Ministers, Copenhagen 1996.

[6] B. Plovsing, E. Thyséll, *Test Cases for Railway Noise* – Nord2000, RL 14/18, Miljøstyrelsens referencelaboratorium for støymålinger, 2018.

[7] Excel charts with test case calculation results, *RailTest_20180928.xlsx* and *RailTestChangeInLW_20180928.xlsx*, DELTA 2018, downloaded from referencelaboratoriet.dk in June 2024.

[8] Excel charts with test case calculation results including L_{AFmax} values, *RailTest_20240807.xlsx* and *RailTestChangeInLW_20240807.xlsx*, Kunskapscentrum om Buller, 2024.