

New data to the Nordic prediction model for train noise

Tomas Jerson (f.d. Ström)

WSP Akustik - Göteborg
Sverige

tomas.jerson@wspgroup.se

ABSTRACT

The analysis of new trains indicates relatively low noise emission levels. Surprisingly, the Y31 Itino diesel electric trains is the most silent among the tested train types. The X50/51 Regina trains and X31/32 trains is noisier and there is only a small noise difference between those train types. One explanation for the differences between the trains can be that the Y31 train is brand new and the other trains are the older and have been in intensive traffic for some year which probably has caused some damage on the wheels.

1. INTRODUCTION

During the last years new types of trains have started to operate on the Swedish railways, and since some basis are missing in the Nordic prediction model, the trains noise emission is non predictable. The author was, in the former decade, employed at Swedish National Testing and Research Institute and at that time engaged in several train noise projects (ref 1, 2, 3, 4), which results served as basis for an earlier revision of the Nordic prediction model. WSP Acoustic has from Banverket (BV, the authority responsible for rail traffic in Sweden) received a research fee to carry out a project aiming to measure noise emission from new train types. The analyzed data will be implemented in the prediction model. The new types of train which have been studied in this project is X31-32 Contessa, X50-54 Regina and Y31-32 Itino. Contessa and Regina are electrical trains and Itino is a diesel electric train. The project has been carried out on rail sections also operated by ordinary rail vehicles and therefore a lot of measurement results from older train vehicles are included. The noise emission from these train passages will be compared with results from the prediction model in a separate report to improve the knowledge concerning the model conformity with present train status.

2. METHOD

The measurements were carried out according to ISO 3095. The measurement series were finished in December 2003. With the exception of fulfilling the acoustic requirements the measurement places were selected by considering the "pass by speed". The aim was to include a speed area as large as possible for different measurements. All the measurements were carried out at 10 m distance from the nearest center of track with the microphone at 1.5 m height above the railhead level. In several cases the measurements also have been carried out at 25 m distance from the nearest center of track with the microphone at 3.5 m height above the railhead level. At every individual passage the L_{AeqT} , L_{AFmax} and the frequency spectrum in third octave bands from 25 – 10000 Hz were stored. The train speed, train length and striking noise i.e. from uneven wheels, were also noticed.

3. RESULT

Noise emission from totally 81 passages at 15 different sections was evaluated according to the Nordic Prediction Model. In order to make it possible to implement the results in the prediction model, the noise measurements and train data have been normalized to train length, measurement distance, measurement height, train speed and the ground damping.. The results for the new train types are divided in speed intervals. The logarithmic mean values for train passages have been calculated in each speed interval.

3.1 Electric train X31 / 32 Contessa

In each case the measurements are carried out on units comprising three railcars. Diagram 1 shows the result as an A-weighted SEL-level (logarithmic mean in 20 km/h interval) for passages with 47 X31-32 trains in different speed.

Diagram 1 shows that the Sound Exposure Level from train pass by in every speed interval differ from the regression line. These differences are probably caused by several reasons. It's well known that wear on wheels and rail has a big impact on the variations in noise emission. It has not been possible to receive a large number of passages at many sites. The noise level from separate trains and sites hackneyed to various extents therefore has

big impact on regression line when the numbers of measurements are few. In low speeds constant noise from sources on the trains as fans, motors, gearboxes etc. can also be important factors for the total noise emission.

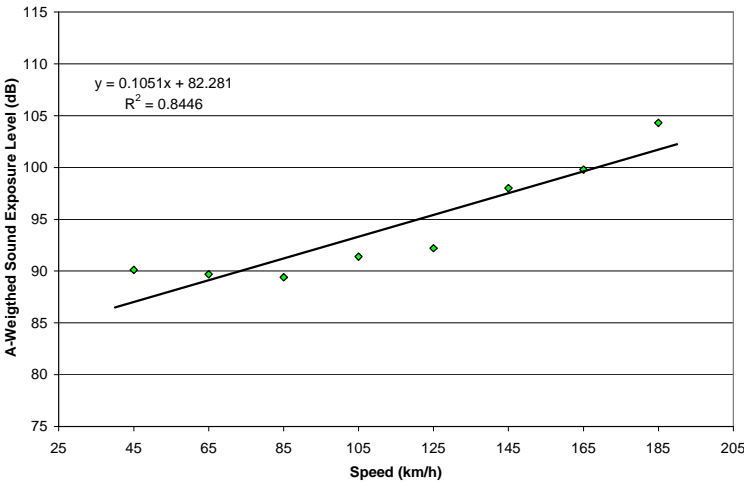


Diagram 1. Correlation between A-Weighted Sound Exposure Level and speed for X31/32 trains

Diagram 2 shows octave band levels for X31/32 trains in different speed areas.

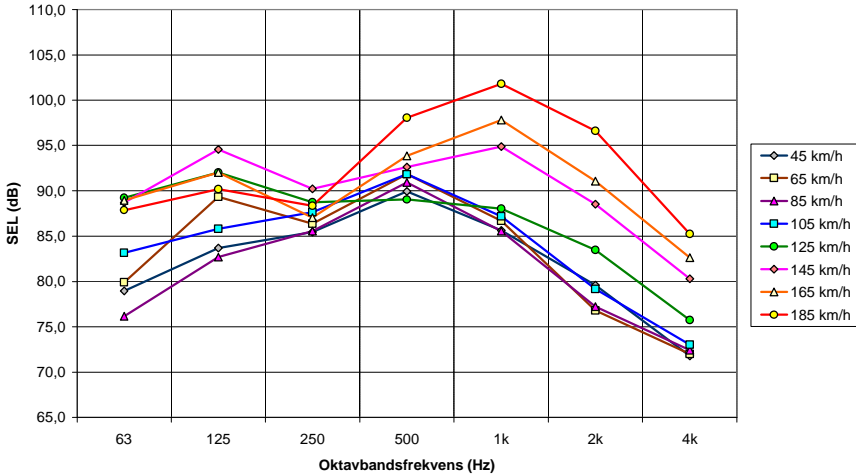


Diagram 2. Logarithmic mean of Sound Exposure Level in octave band for X31/32 trains in speed interval 45 – 185 km/h normalized to 10 m distance from the track middle

3:2 Electric train X50 – 54 Regina

Measurements have in the most cases been carried out on trains with 3 (rail cars) vehicles but in some few cases also on trains with 2 (rail cars) vehicles. Diagram 3 shows the result as an A-weighted Sound Exposure Level for pas byes with X50-51 trains in different speeds.

The total number of X50 – 51 train passages are limited to 22. In the diagram 3 one can see that the Sound Exposure Level from train passages in respective speed interval differ from the regression line. The deviation might have many explanations. It's well known that damaged wheels and rails have influence on the noise emission level. At many sites it have not been possible to measure a great number of passages in a large number

of speed intervals. The noise level from each trains and sites hackneyed to various extent has therefore big impact on the statistic significance when then number of measurements is limited.

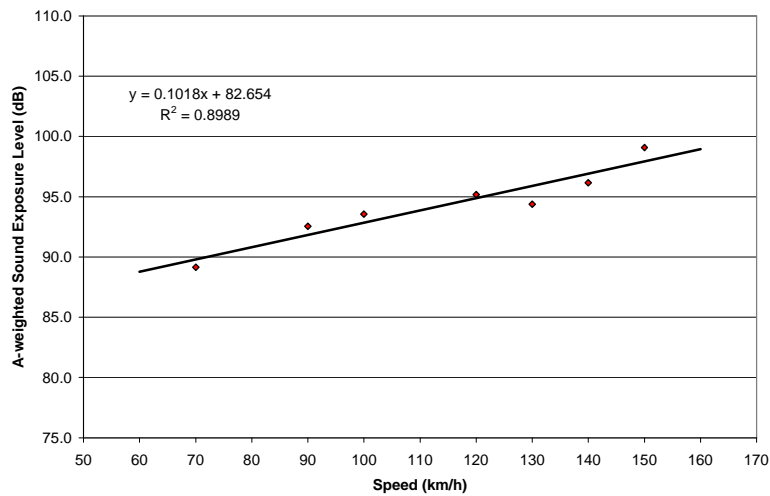


Diagram 3. Connection between A-weighted Sound Exposure Level and speed for X50 - 51 trains

Diagram 4 shows octave band levels for X50/51 trains in different speed areas.

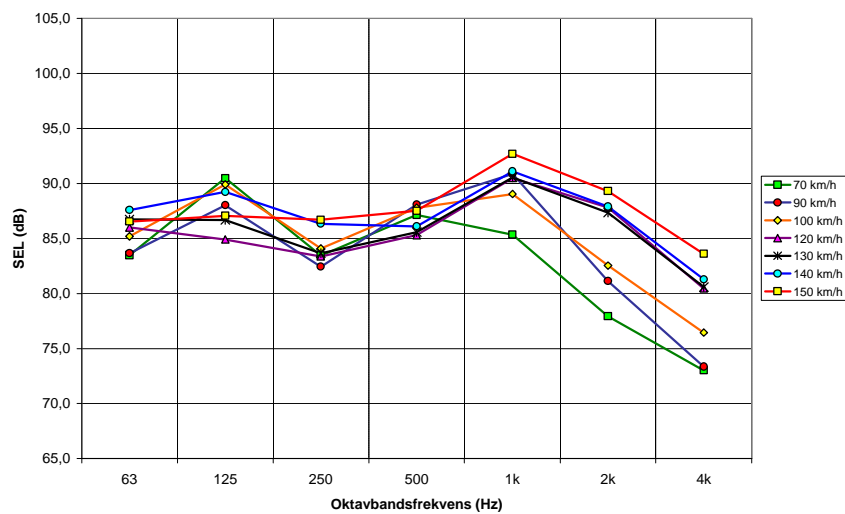


Diagram 4. Logarithmic mean of Sound Exposure Level in octave band for X50/51 trains in speed interval from 70 – 150 km/h normalized to 10 m distance from the track middle

In the frequency spectrum from the train passage one can see that the highest Sound Exposure Level occurs in the 1000 Hz octave band and that the level will increase as the speed is raised.

3:3 Diesel train Y31/ 32 Itino

The Y31/32 Itino is a modern diesel electrical train and it has in 2003 gradually been taken in regular traffic at many non-electrified distances. In diagram 5 results are presented as A-weighted Sound Exposure Level (logarithmic mean in 10 km/h intervals) with Y31 train passages in different speeds.

The total number of measured passages with Y31 trains is 12 st and they are carried out at 2 places. The good curve fit in the regression analysis might be explained by the fact that there are only 2 trains (brand new and therefore unworn wheels) that have passed the measurement site at all occasions. The deviations that still occur can eventually depend on differences in driving (non ore a little throttle on the diesel engines at the pass byes).

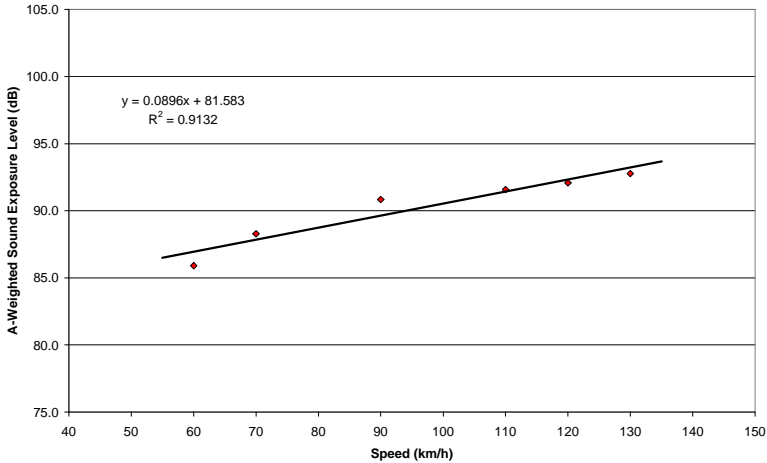


Diagram 5. –Correlation between A-weighted Sound Exposure Level and speed for Y31 - 32 diesel electric train

Diagram 6 shows the frequency spectrum for Y31 diesel train in different speed.

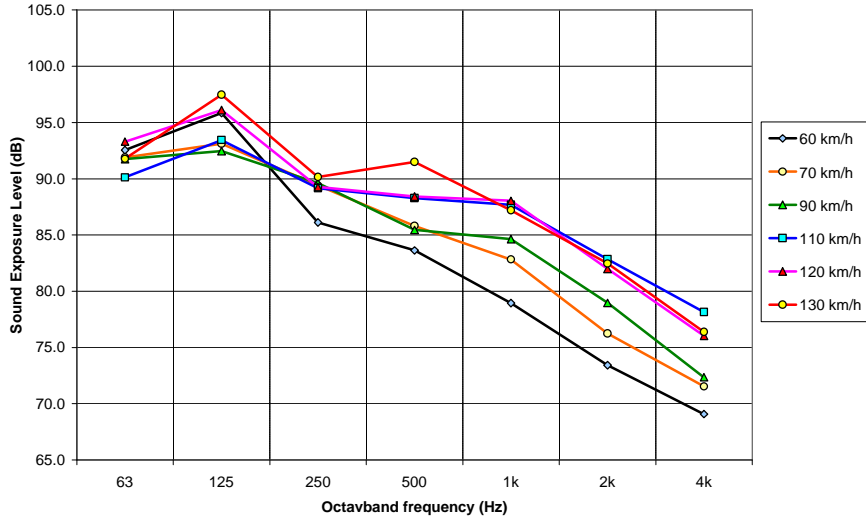


Diagram 6. Logarithmic mean for Sound Exposure Level in octave bands for X31trains in different speed intervals 60 – 130 km/h normalized to 10 m distance from track middle

In the frequency spectrum one can see that the highest Sound Exposure Level occurs in the 125 Hz octave band. The high level in this low frequency region is probably caused by the two big diesel engines that operate the electric generators, which produce electricity for the electric engines in the bogies used for the traction.

4. CONCLUSION

The analysis of new trains indicates relatively low noise emission levels. This is rather natural since the acoustic properties have become an important part, to reduce new rail vehicles influence on the surroundings. Surprisingly, the Y31 Itino diesel train is the most silent of the tested train types. The noise levels from X51 Regina and X31/32 Contessa are quite similar. One of the explanations for the differences between the train types can be that the Y31 are newer than the other two types of train vehicles.

4. REFERENCES

1. Nordiska Ministerrådet "Railway Traffic Noise – Nordic Prediction Method indata till nordiska beräkningsmodellen" Tema Nord 1996:524
2. Clara Göransson, Tomas Ström "Externt buller från svenska tågtyper – Nya indata till nordiska beräkningsmodellen" SP Rapport 1994:25.
3. Tomas Ström "Buller från persontåg i låga hastigheter" SP Rapport 1993:37
4. Tomas Ström "Buller från persontåg i höga hastigheter" SP Rapport 1992:01
5. Tomas Ström "Buller från snabbtåg – Resultat från fälmätningar utförda på västra stambanan" SP Rapport 1991:43