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NOISE CONTROL IN THE ENGINEER'S CAB OF AN ELECTRIC LOCOMOTIVE ENGINE OF THE DUTCH RAILWAYS, SERIES NUMBER 1305.

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INTRODUCTION

Due to the increasing passenger traffic the Dutch Railways (NS) are forced to keep longer in operation the existing locomotive engine of the series 1100 and 1300.
To prolong the (technical) operational life of the engine a general revision will be executed.
Part of a general revision is the reduction of the sound level in the engineer's cab. The equivalent soundlevel in the starting-point was 85 dB(A). The object of this investigation was to reduce this sound level to 80 dB(A) or lower.

NOISE SOURCES IN THE ELECTRIC LOCOMOTIVE

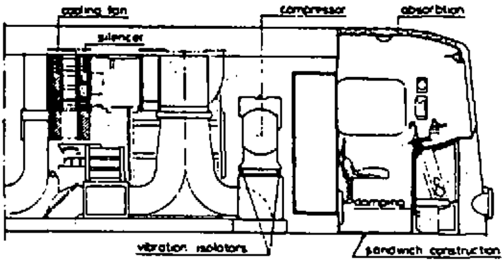
In figure 1 a cross-section and a ground view of the locomotive is shown with the two principal noise sources. These sources are the cooling fans of the electric motors and the compressor for the compressed air. When the locomotive is running, the noise of the wheels on the rails is added to the aforesaid sources.
Besides there are the peak levels in the engineer's cab caused by the blow off in the brake-valve, the air-horn and the audible signals.

RESULTS OF THE MEASUREMENTS

The sound- and vibration measurements were carried out in a stationary and moving locomotive engine.
First of all the sound insulation was measured between the engine room and the engineer's cab. Then the air-borne transmission of the fan and compressor noise to the cab was calculated. The results of these caclulations for the fan are shown in figure 2.

Figure 1

Cross-section of the locomotive engine NS 1300



Further, vibration measurements were performed on the different panels in the cab when the cooling-fan and the compressor were running separately.
The sound radiation of the panels was then calculated whereby the radiation factor was determined according to reference [1]
The results for the compressor are shown in figure 4. The conclusion from these measurements are as follows: the noise of the cooling fan is principally caused by air-borne sound transmission. The noise of compressor in the cab comes from structure born sound. Table 1 shows the results of the measurements in a driving locomotive.
Further sound and vibration measurements are done as the locomotive was driving on a section of a line. The results of the sound measurements are at three speeds shown in table 1.
As appears from this table the noise generated by the rolling wheels on the rails becomes important at a speed of 130 km/h.
The contribution is 80 dB(A) as the overall sound level reaches a level of 85 dB(A).

MEASURES ON THE LOCOMOTIVE ENGINE

To decrease the air borne transmission from the engine room to the cab the following measures have been taken:
- a sound silencer on the exhaust openings of the fan
- new double doors between the engine room and the cab
- about 16 m2 absorbent lining from 50 mm rockwool in the engine room.

To reduce the vibration transmission from the fan and the compressor new isolators were installed. The fan was provided with rubber isolators and the compressor with visco-elastic damped steel springs. The latter had a natural frequency of 3.3 Hz. As horizontal accelerations of 50 m/s2 can occur special precautions were taken.

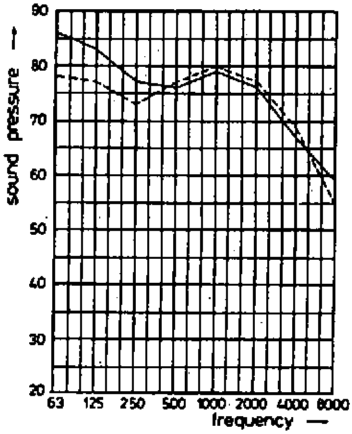


Figure 2
---- calculated sound level of the fan based on the measured sound insulation
—— measured sound level of the fan

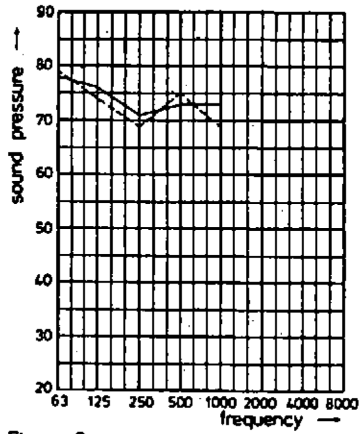


Figure 3
---- calculated sound level of the compressor based on the vibration measurements
—— measured sound level of the compressor

The roof and panels were the principal radiation surfaces of noise caused by structure borne vibration. To decrease the radiation these panels were damped by providing a sandwich construction. On the existing plates a visco elastic layer of 1 mm was attached. The latter was covered with 1 mm steel plate.
The same system was used for the floor. The other plates were provided with 3 mm visco-elastic material on about 75% of their surface.
In the cab was an absorbing ceiling installed. The sound insulation of the enclosure of the horn and braking valve was improved by using sandwich plates.

Table 1. Sound measurements in the cab of a driving locomotive

Speed	fan, compressor operating	all sources switched off rolling noise
80 km/h	83 dB(A)	73 dB(A)
100 km/h	83 dB(A)	78 dB(A)
130 km/h	85 dB(A)	80 dB(A)

RESULTS

The sound level in the engineer's cab before and after the measures for a stationary locomotive are shown in table 2. The reduction of the fan noise is 10 dB(A) and for the compressor 14 dB(A).
The results for the rolling noise when the locomotive is driving at three speeds are shown in table 3.
The conclusion of the measurements is that the sound level is determined by the rolling noise. The equivalent sound level in the engineer's cab at 130 km/h when all noise sources are operating was 75 dB(A).

Table 2. Sound measurements in the cab of a stationary locomotive

Operating condition	before the measures	after the measures
cooling fan	79 dB(A)	69 dB(A)
compressor	75 dB(A)	61 dB(A)
horn (low)	100 dB(A)	93 dB(A)
horn (high)	95 dB(A)	90 dB(A)

Table 3. Rolling noise in the cab

Speed	before the measures	after the measures
80 km/h	73 dB(A)	66 dB(A)
100 km/h	78 dB(A)	70 dB(A)
130 km/h	80 dB(A)	74 dB(A)

Reference

[1] L. Cremer, M. Heckl, Structure-Borne Sound, Springer Verlag
E.E. Ungar