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CONTROL OF ROAD TRAFFIC NOISE AND ENERGY CONSUMPTION

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I - INTRODUCTION

Road traffic noise is by far the main cause of adverse opinion about the environmental conditions in industrialised countries.

Road transport is very dependent on the supply of petrol and accounts for between one quarter and more than a half of the total consumption of the product. Thus we need to consider the interrelations between the reductions in noise and energy consumption.

II - GENERAL INTERRELATIONS ?

2.1 - Operating efficiency and the emission of noise

Improvements in the operating efficiency of machines is a matter of reducing the losses of energy in the form of heat but we cannot make use of anything comparable to Carnot cycle theory when considering the emission of noise. This emission is associated with the following mechanisms :

. Generation of the noise within a fluid medium (combustion, aerodynamic disturbances, etc.).
. Propagation of the consequent vibration within the mechanical structure.
. Radiation of the noise from the mechanical structure into the surrounding air.
. Perception of the noise by the ear which responds to only a small fraction of the total acoustic energy.

It cannot be assumed, given the mechanisms involved in the production of noise, that the more efficient machine will be quieter. Only where there are few mechanisms and sources involved, actions taken to improve efficiency result in an automatic reduction of noise. This applies, for example, in the case of jet engines and fans that can be regarded as sources of aerodynamic noise where no mechanical structure is involved.

2.2 - Reduction in the demand for energy

For a machine as well as for a journey, a reduction in the useful energy consumed is usually associated with a reduction in the noise. This reasoning does not necessarily apply when the change involves the introduction of a new technique such as the operation of a 2-stroke in place of a 4-stroke engine. Figure 1 shows how the noise level increase only slightly with engine power rating. The common example of the thirsty but quiet 6-cylinder engines fitted to American cars serves to remind us that we need to have some reservations concerning the benefits supposed to arise as a systematic result of reducing the demand for power.

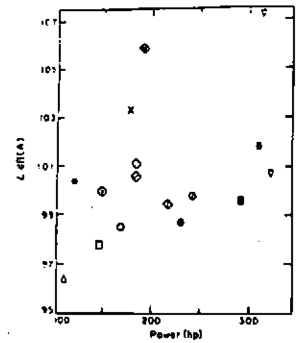

Figure 1 Sound pressure levels under conditions corresponding to those defined by the ISO standard for different heavy vehicle engines. Source Renault.

III - THE VEHICLES

We now consider the reduction of noise and energy consumption with respect to the design of the vehicles on noting that in Europe, under the conditions given by the EEC regulations, there does not appear to be any general correlation between the emission of noise and the consumption of energy (see fig.2).

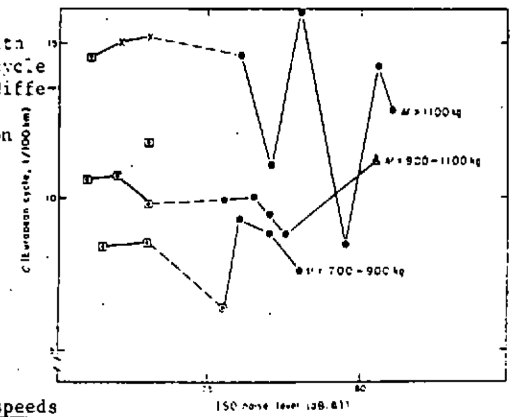

Fig.2 Fuel consumption with respect to the European cycle and ISO noise level for different models of car

- ▭ Automatic transmission
- o Long gear ratios
- ▲ Air controled
- D Diesel
- x 5-speed

3.1 - Engine and vehicle speeds

Speeds is nearly always the main parameter to be taken into account when considering either noise or energy consumption.

The level of the noise emitted by an international combustion or a hydraulic drive unit increases with α log N, where α has a value of between 25 and 50 depending on the type of engine or hydraulic drive unit involved, and N is its speed. Energy losses associated with mechanical displacements, friction and pumping operations also increase with the speed N. Thus the reduction of this speed usually leads to reductions in both noise and energy consumption. An example here is the use of a larger capacity engine on the Renault R5 GTL vehicle. In the case of tyre operation we do not have a clear understanding of the relations involving the vehicle speed V as the main factor giving rise to increases in the resistance to forward motion and the emission of noise (see fig.3). It can be assumed that the frequency and intensity of the successive impacts suffered by the tyres are growing with the vehicles speed V and this would account to some extent for the resistance to forward motion and the emission of tyre-road contact noise increasing with V^2 and 30 log V.

Mark of vehicle	Engine rating (HP)	Engine speed (rpm)	Engine capacity (cc)	ISO noise level (dBA)	Fuel consumption (litres/100 km)			
					90 km/h	120 km/h	Urban cycle	Combined cycle
R5 L	36	5500	845	79-78	6.3		8.1	
R5 TL	44	5500	956	76-77	6.1	8.6	9.0	7.9
R5 GTL	47	4400	1100	74-75	4.9	6.8	6.3	6.0

Table 1

Characteristics of successive Renault R5 vehicles

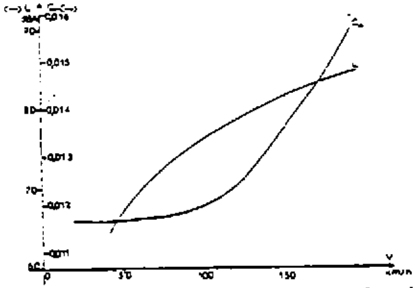

Fig.3 : Maximum road tyre noise level (dBA) and rolling resistance for a passenger car versus speed
Cr : tyre 180 x 65 - HR 390 - Load 3300 -
L is approximately by
$L = 16,162 + 30 \log \frac{V}{10}$

3.2 - Enclosure of the sources of noise

Enclosure of the engine and a part of the transmission system is in fact the most effective way of sound proofing road vehicles leading to reductions of 6 to 12 dB(A) in noise level.

The weight of the vehicle

Increases in the weight of the vehicle due to the provision of noise screens and additional cooling capacity per dB(A) reduction in noise level can amount to 4 kg in the case of cars and between 5 and 15 kg in the case of heavy lorries. For a small lorry see fig.4. The additional fuel consumption amounts to :
0.3 to 0.5 per cent per dB(A) reduction of noise in the case of cars.
0.02 to 0.05 per cent per dB(A) reduction of noise in the case of the most heavy vehicles.

In the case of new designs of vehicles it is easier for the noise screens to be provided as an integral part of the engine or vehicle.

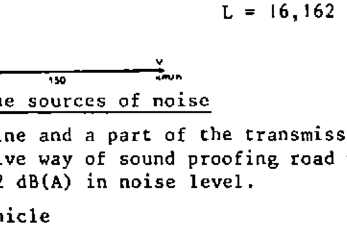

Figure 4 Relation between noise reduction and weight increase for the Magirus Deutz 7.5T

-Aerodynamic characterictics

The flow of air around the engine and beneath the vehicle can be improved in particular on streamlining the underbody of the vehicle. Such treatment has led to fuel consumption savings of as much as 10 per cent at high running speeds for certain vehicles.