FUTURE PROJECTED VEHICLE SOURCE NOISE EMISSION LEVELS
FOR USE IN HIGHWAY TRAFFIC NOISE PREDICTION CALCULATIONS
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In any highway noise prediction scheme, it is imperative that realistic source emission levels be inserted into the mathematical models in order to produce results that will correlate with measured levels. Traffic flow rate and traffic mix must be taken into account. It is also necessary to insert vehicle source noise levels that are representative of the specific mode of operation that is being modeled. For trucks, each speed and acceleration condition will necessitate a separate consideration of powerplant related noise and tire-road surface interaction noise. Tire-road surface interaction noise is primarily vehicle speed dependent but is also influenced by tire design, expecially tread pattern, number of tires used on the vehicle, and road surface characteristics. A single level number can only be used to represent a class of vehicles if that number takes into account the specific conditions of engine operation and speed in the case being considered.

While EPA has not published new truck noise regulations as of this date, the fact is that the differences in the resulting highway traffic noise levels, which could occur due to regulation of truck powerplant sound levels, are small, regardless of which of the proposed levels are chosen. That is, the choice of any level at or below 83 dBA will have little bearing on future highway traffic noise levels. While the cost of lower levels will be significant to the user of the truck and ultimately to the public, the benefit, particularly in terms of lower highway noise levels, will be minimal. Even taking urban street scenarios into account, it can be shown that setting regulated levels for new trucks below 83 dBA is not cost beneficial (1).

More importantly, it must be recognized that the potential benefit of regulating new trucks will not be realized without an effective enforcement program locally as well as nationally to eliminate poorly maintained vehicles and those modified vehicles that produce excessive noise. It will also be necessary to control the noise from new tires on some basis of performance so that only the better, quieter tires will be produced in the future. As it stands today, the best known technology for control of tire noise can yield no promise of appreciable noise reduction below that of the lowest noise level tires currently being produced. However, there is a significant gain to be realized by removing the noisier varieties of tires from our roads.

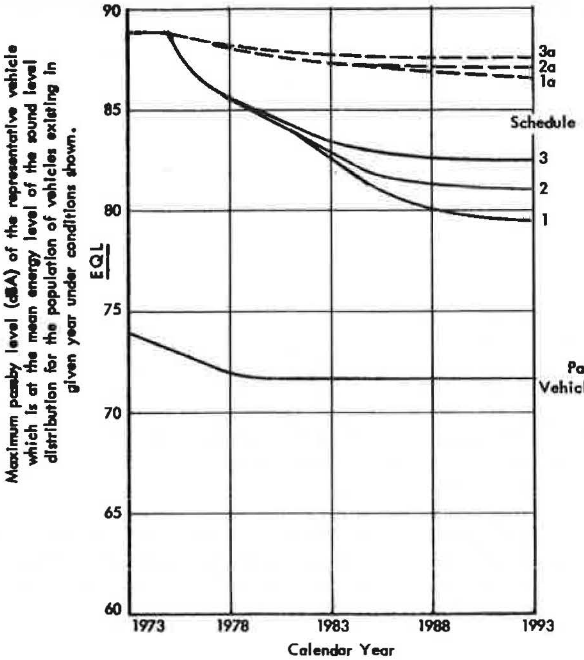
General Motors submitted two documents (2) in response to the EPA Proposed Rule Making for Noise Emission Standards for New Medium and Heavy Trucks. The information contained herein constitutes part of the material developed for these documents. Details of the calculation procedures are included in the GM reports. The purpose of the calculations was to predict the potential incremental noise reduction in a community that could be achieved by reduced vehicle and tire source emission levels as a result of proposed standards. To allow the use of that previously developed information in calculations involving various proportions of traffic mix, it is necessary to present the data individually for heavy vehicles and light vehicles. Calculations have been performed on 2 modles that illustrate the urban freeway cruise situations with vehicles traveling at 55 mph (88 km/h) and the urban street cruise condition with vehicles traveling at 35 mph (56 km/h).

The EQL value used in these models was defined as the maximum passby level (dBA) of the representative vehicle, which is at the mean energy of the sound level distribution for the population of these vehicles. Figure 1 and Figure 2 show the projected EQL values according to various regulatory schedules of Tabel 1 for 2 classes of vehicles operating at 55 and 35 mph (88 and 56 km/h) respectively; i.e., medium and heavy trucks over 10,000 lb (4536 kg) GVWR and passenger cars and light trucks less than 10,000 lb (4536 kg) GVWR. It should be noted that truck powerplant noise and tire noise are presented as a single combined level notwithstanding that they were derived separately and that the levels shown are highly dependent on speed. The EQL values shown are the best available estimates of the noise levels of vehicles operating in the level road cruise condition and include a 1.5 dBA attenuation factor assumed for measurements made at typical highway sites as differentiated from a hard site test facility. The populations assumed in any given year are a proportioned mix of old and new vehicles extrapolated from data from U.S. Bureau of Census, "Truck Inventory and Use Survey" (1972). It will be seen by means of the equation, Figure 3, that the EQL value defined above is used as the level at 50 ft (15.24 m), $L_{(50\ ft)}$, to determine the hourly equivalent energy level [Leq(h)] that that vehicle class contributes.

Since it is impossible at this time to determine the effectiveness of the enforcement of the Interstate Carrier regulation and anticipated new tire regulations, 2 conditions are shown: (a) with 100 percent enforcement such that all trucks comply

Figure 1.

PROJECTED VEHICLE EQL VALUES FOR FUTURE YEARS
Based upon levels and years proposed by EPA
in Proposed Standards for Medium and Heavy Duty Trucks
Docket No. ONAC 74-1
FREEWAY SPEED 55 MPH



Medium and Heavy Trucks over 10,000 GVWR

Projected Levels are based upon: All new manufactured trucks meet the regulated levels.

Schedules 1a, 2a and 3a assume no enforcement of Interstate Carrier or new tire regulations.

Schedules 1, 2 and 3 assume that the Interstate Carrier regulations plus new tire regulations are 100% enforced.

Figure 2.

PROJECTED VEHICLE EQL VALUES FOR FUTURE YEARS
Based upon levels and years proposed by EPA
in Proposed Standards for Medium and Heavy Duty Trucks
Docket No. ONAC 74-1
URBAN STREET SPEED 35 MPH

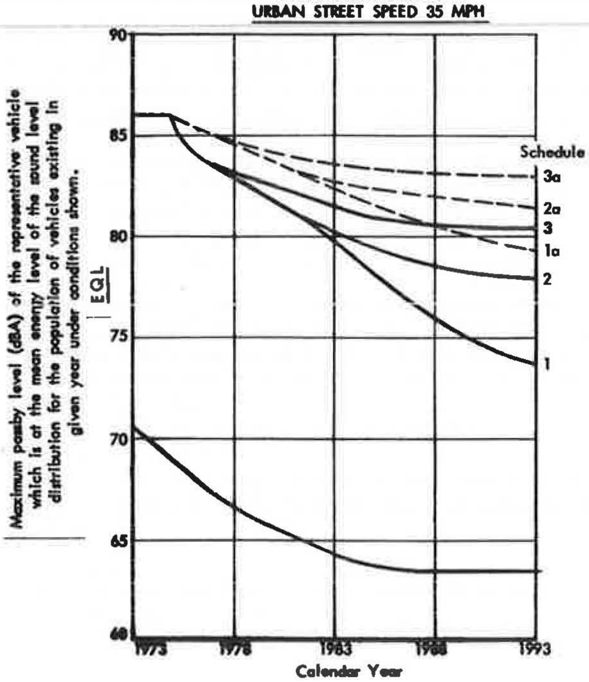


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Table 1.

New Medium and Heavy Truck
Regulated Level Reduction Schedule
(per SAE J366b)

Schedule 1	83 dBA in 1977 80 dBA in 1981 75 dBA in 1983
Schedule 2	83 dBA in 1977 no further reduction
Schedule 3	86 dBA in 1977 no further reduction

Passenger Car and Light Truck Schedule (per SAE J986a)

80 dBA in 1975
no further reduction

Figure 3.

Equation for Determining $Leq_{(h)}$

$$Leq_{(h)}(dB) = L_{(50\ feet)} + 10 \log \left(\frac{V}{SD}\right) + 1.7$$

where $L_{(50\ feet)}$ = unit vehicle maximum passby noise level at 50 feet, (corresponds to the EQL value for a class of vehicles).

V = vehicles per hour

S = speed in miles per hour

D = distance from the roadway in feet

$Leq_{(h)}(dB)$ = hourly mean traffic noise level at distance D

Note: 1 ft = 0.3048 m.

with regulations, and are equipped with low noise rib-type tires, and (b) with no enforcement such that the existing fleet in 1973 typifies the levels of the trucks not covered by the new truck regulations. Since such a marked difference in truck noise on the streets occurs between a 100 percent enforcement condition and a no enforcement condition, it will be necessary when making the computations to qualify the conclusions according to the assessment of the degree of enforcement that can be forecast. Since the schedule and levels of new truck regulation are not known, the schedule and levels in the regulation proposed by EPA as of October 30, 1974, were assumed and are shown as Schedule 1 in Table 1. Schedule 2 is the General Motors recommendation for truck sound levels reduction to 83 dBA. Schedule 3 assumes no further reduction below the 86 dBA level as a new vehicle regulation.

Only 1 curve at each speed in Figures 1 and 2 are shown for passenger cars and light trucks less than 10,000 lb (4536 kg) GVW. These curves are derived from data starting with the population of these vehicles existing in 1973 that are now being replaced with vehicles of this class that are currently being produced to meet SAE J986a levels of 80 dBA. It was assumed that these new vehicles will dominate the population of light vehicles in the time frames shown. The realities of poor maintenance and modifications that produce excessive noise must be handled by user regulations, but no estimate of this effect is illustrated in this presentation. For the situations of 35 and 55-mph (56 and 88-km/h) cruise, the EQL values presented in Figures 1 and 2 can be used to determine the total equivalent energy $L_{eq(h)}$ of a given mix of vehicles representing the classes of vehicles being considered. The EQL levels for each class of vehicles must be converted to equivalent energy $L_{eq(h)}$ values to determine the energy contribution in accordance with the equation in Figure 3. The resultant $L_{eq(h)}$ values for the specified vehicle classes can then be summed logarithmically to obtain the total source emission equivalent energy level.

To determine the level of unit truck noise that should be used as input to highway traffic noise computations, the appropriate schedule that corresponds to the regulated level in effect must first be selected. As an illustration, assume that a regulated level of 83 dBA is chosen that corresponds to Schedule 2 or Schedule 2a. For a prediction in a given year, say 1985, the expected level of trucks at 55 mph from Figure 1 would be 82 dBA with 100 percent enforcement of in-use regulations, or 87.2 dBA with no enforcement. The importance of the enforcement aspect of noise control on the older vehicles is obvious. It is assumed that the newly manufactured vehicles comply with the new product regulations in effect to control low-speed engine-related noise. At this time, it is not possible to assess the degree of enforcement that will be attained. Although it is improbable that complete enforcement will be attained, the level of 82 dBA is chosen as an example.

For passenger cars and light trucks the corresponding value would be 71.7 at 55 mph (88 km/h) in 1985. This level is based on the levels of new light vehicles produced to meet a maximum level of 80 dBA per the SAE J986a standard. The initial (1973) level of 74 dBA was established from roadside data and therefore represents the maximum level which might be anticipated if local enforcement does not reduce the levels of the poorly maintained and modified vehicles. With reasonable maintenance of 1975 and later light vehicles in their "as manufactured" condition, the cruise passby levels under these speed conditions are determined by tire noise.

In this illustration the values to be used in establishing the L_{eq} equivalent energy levels for any given highway situation would be 82 dBA for trucks over 10,000 lb (4536 kg) GVWR and 71.7 dBA for passenger cars and light trucks. These values are then used in the equation shown previously in Figure 3 relating the maximum level at 50 ft (15.24 m) distance with the $L_{eq(h)}$ based upon traffic volume, speed and receiver distance. Thus the hourly energy contribution for each class of vehicles is determined. To obtain the total traffic equivalent energy level for that hour, $L_{eq(h)}$, the energy contributions of each component of the traffic mix for that traffic situation must be summed logarithmically.

References

1. GM comments to EPA; Letter USG 350-75-11, dated May 30, 1975.

   GM comments to Council on Wage & Price Stability; Letter USG 350-75-14, dated July 2, 1975.

2. GM comments to EPA; Report USG 350-74-22, dated December 20, 1974, Section VI.

   GM comments to EPA; Report USG 350-75-5, dated March 14, 1975, pages 40-56.