

Sound Advice

Investigation of HVAC cabin noise

An investigation of in-cabin noise of vehicles reveals that the design of the HVAC system has a major influence on the vehicle's in-cabin acoustic performance.



Simon Watkins Professor, Aerospace Mechanical & Manufacturing Engineering



Satya Prasad Mavuri Research Fellow - AutoCRC
School of Aerospace, Mechanical and Manufacturing Engineering
RMIT University, Australia

Regulations, like Australian Vehicle Standard Rules, are in practice to control the level of noise emitted by vehicles. The Environment Protection Act (EPA) makes it an offence to own or use a vehicle which exceeds prescribed noise levels. Currently, there are no regulations in practice to limit the in-cabin vehicle noise, other than the manufacturer's internal target levels. However, noise as part of Noise, Vibration and Harshness (NVH), driving comfort and quality of ride feeling were some of the criteria considered for the tests carried out by various organisations.

Consumer awareness is made through comprehensive road tests of new and used vehicles and the results are provided by various organisations across the world, in Australia by RACV. In these tests, noise is rated by subjective evaluation while driving the vehicle to check driving smoothness with respect to engine noise while at constant speed or acceleration and also aerodynamic noise intrusion. A measure of noise efficiency, the star rating system, has a minimum of one star (poor quality or noisy) and a maximum of five (excellent quality or very quiet), by means of which we can directly compare a great range of similar products from various manufacturers. For example, star ratings for the noise can be seen under performance and handling refinements in www.racv.com.au, www.whatcar.co.uk.

Importance of sound or noise in safe driving cannot be ignored alongside other psychological effects. Personal subjective representative noise tests are conducted as part of rating new vehicles. But these tests are done mostly to trace intrusive noises like engine noise at constant road speed or while accelerating, and aerodynamic noise in the cabin. In-cabin noise sources like the HVAC system flow are generally not considered in these tests.

Following are the some of the observations:

- There are no appropriate testing standards and no regulations on the vehicle in-cabin noise exposure levels.
- Most car manufacturers and their components (like aerodynamic noise, tyre noise, HVAC system operation noise), do not show noise level as one of the specifications.

There is an acute shortage of noise data.

- The limited noise data that are available are made by different labs, using different equipment and methods. Such data are difficult to compare.
- Most vehicle component manufacturers' list "absolute noise" level measured in sound-proof and (sometimes) anechoic environments. Such data are not realistic and are difficult to use in real life.
- The high number of component manufacturers and models makes it difficult to compare products across brands.

Noise and vibration have considerable influence on a customer's perception of vehicle quality. Cabin interior noise levels, therefore become a key criteria. With today's increased emphasis on total sensory comfort, acoustic comfort and sound quality have become important considerations in the design of new vehicles and in the assessment of existing vehicles where complaints about excessive or intrusive noise have occurred.

RMIT, in collaboration with Air International Thermal Systems and AutoCRC, surveyed in-cabin noise levels present in small, mid-size, and large cars as well as some trucks. Relatively new production vehicles were used and tests were conducted at idle (vehicle stationary) and under a range of road speeds on smooth roads. A binaural head system was used in the front passenger seat to measure the noise levels and psychoacoustic parameters were also investigated.

It is the purpose of this study to introduce a standard test procedure of measuring vehicle in-cabin noise levels. A combined vehicle base noise with all possible sources like HVAC system, tyres, aerodynamics, engine-off, idling vehicle conditions, on-road measures were considered for rating the total vehicle cabin noise rating criteria. Results were analysed and used to determine a star rating for vehicle industry. A new rating criteria has been introduced which incorporates the noise, communication and annoyance of the measured data in giving the stars of quietness. Using sensitivity analysis, weightage is given to those parameters having prominent impact on the in-cabin noise levels, to arrive at a combined factor, which then is translated into the star rating. Minimum noise limits are designed to distinguish the best cabins, then to encourage the poor designs to improve further.

The objective of this investigation is to inform the reader of potential labelling programme option and our assessment of which are the most appropriate, based on the research conducted.