

Detonation on impact – hearing damage due to collision noise and airbags

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Introduction

According to a report issued at the 1998 DAGA conference [1], the deployment of airbags significantly exceeds the limits for impulse noise and may cause permanent hearing damage. But additional questions needed to be clarified:

- How loud is collision noise (without airbag)? Is it louder than the deployment of the airbag?
- Are the levels of the 1997/98 study also applicable to more recent vehicles?
- What are the sound levels caused by airbags that are being installed on the sides of car seats?

Since no data were available from the automobile industry, we decided to carry out our own tests.

1. Measurement of collision noise

1.1 Background

In an exchange of correspondence with a Swiss customer on the question of hearing damage caused by airbags, Mercedes-Benz (Schweiz) AG stated that, after consultation with its parent company in Germany, it “could be concluded that the noise resulting from a collision would override that caused by the deployment of the airbag...”.

If this conclusion were to be confirmed, there would be little purpose in attempting to reduce the level of noise resulting from the detonation of an airbag. This claim therefore needed to be examined more closely.

1.2 Method used for testing

Our study was carried out at a test centre in Wildhaus. We caused a Type 2 VW Golf to collide with the rear wing of a Citroën BX at 50 kilometres per hour. Photo 1 depicts the situation during the preparation stage.



Photo 1

Our measurements were made inside the Golf with the window open on the driver's side. The measurement equipment was installed behind the driver's and passenger's seats and consisted of a Norsonic 116 precision sound level meter with separate preamplifier and microphone, a Casio DA-2 DAT recorder in a transportable case, a Larson-Davis LD 710M integrating sound level meter – also equipped with a separate microphone installed on the headrests – and a radio transmitter. Tension and safety belts were installed in order to protect these devices not only against the shock of the impact,

but also against the resulting whiplash. All measuring devices survived without damage, and the DAT recording was uninterrupted. It indicated on the driver's side vibration-induced noise caused by movements of the backrests and wind noise due to the open window. Therefore, the measurements taken on the passenger's side were used for the evaluation.

Outside the vehicles, at a distance of 5 metres from the point of impact, 2 additional integrating sound level meters (Norsonic 116, LD 710) were installed.

1.3 Results

Table 1 shows the results in comparison with SUVA's impulse noise limit and typical levels for airbags on the driver's side.

Level =>	L(Peak)	L _{max} Slow	SEL
Measurement point	dB(C)	dB(A)	dB(A)
Interior, passenger	133	100	101
Exterior, 5 metres	128	99	99
SUVA threshold level	(140)		125
Airbag on driver's side	160		131

Table 1: Collision noise, SUVA limit level, airbag level

1.4 Discussion

Even with an open window, the interior noise resulting from a collision at 50 kilometres per hour is more than 20 dB SEL below the impulse noise limit. This means that hearing damage can be excluded. The noise resulting from the collision is also approximately 30 dB below that resulting from the deployment of the airbag in terms of both the peak and the sound exposure level. While higher levels have to be anticipated from collisions at higher speeds, a closed window will reduce them by more than 10 dB.

It may be assumed that the collision noise inside more expensive vehicles will be lower than in the Golf 2 due to efficient insulation against external noise, good sound absorption inside and the quality of materials that should not burst with a loud bang in a crash.

Therefore the allegation that the noise resulting from the detonation of the airbag is overridden by that resulting from the collision cannot be upheld.

2. Measurements on airbags at the front and side

2.1 Objective

The aim of these measurements was to determine the hazard to hearing due to deployment of one or more airbags in a current and popular vehicle, and to compare the results with those obtained from earlier, improvised tests. We were also interested in the degree to which it was possible to reproduce the readings thus obtained.

2.2 Method used for testing

We carried out our measurements indoors using a new VW Golf 4 (photo 2). Dummies were placed on the front seats, the microphones were installed in shock mounts (vibration isolation) and positioned at ear level (photo 3). In

all, we deployed 7 airbags on the driver's side and 5 on the passenger's side.



Photo 2

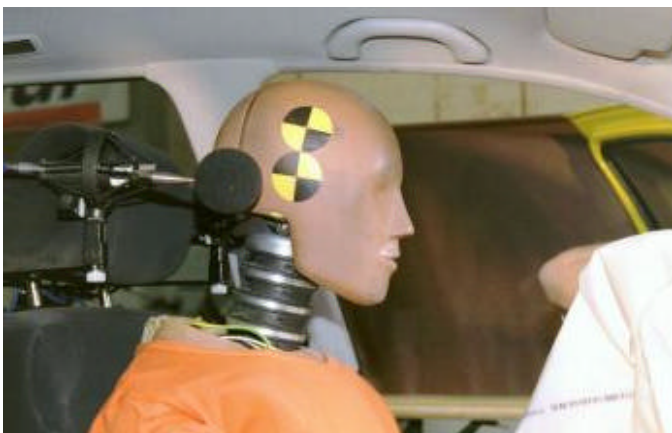


Photo 3

2.2 Results of frontal airbags

Driver's side

The airbag on the driver's side exposed the dummy's ears to a peak level of approx. 160 dB(C) and a SEL of approx. 130 dB(A). The reading obtained for the ear close to the window was several dB higher. This means that SUVA's impulse noise limit was clearly exceeded.

From the airbag on the passenger's side, the driver was exposed to almost the same peak and SEL levels.

When both frontal airbags are deployed, the peak level is barely any higher, but the sound exposure level increases by approx. 3 dB to well above 130 dB(A).

Passenger's side

The levels to which the passenger (a small person) is exposed are slightly higher: peak levels of 162 to 164 dB(C) and SELs up to 136 dB(A), i.e. more than 10 dB above SUVA's impulse noise limit. For passengers, it is always their "own" airbag that is of relevance, while the driver's barely plays a role at all.

Results of repeated measurements of the same situation were generally within approx. ±1 dB.

2.3 Influence of window

An open window only has an influence on airbags placed at the front, only on the window side and only at low frequencies (cf. figures 4a and 4b): C-weighted levels are approximately 3 dB lower than with closed windows. This can reduce the protective effect attributed to low frequencies.

In the upper frequency range which is more critical with respect to hearing damage, the levels are lower by a maximum of 1 dB(A), but they may also increase.

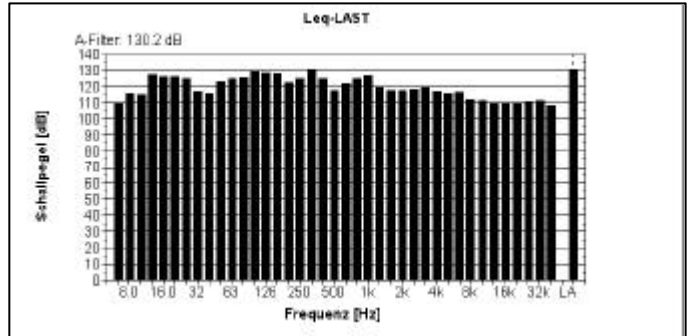


Fig. 4a: Driver airbag (for driver, windows closed)

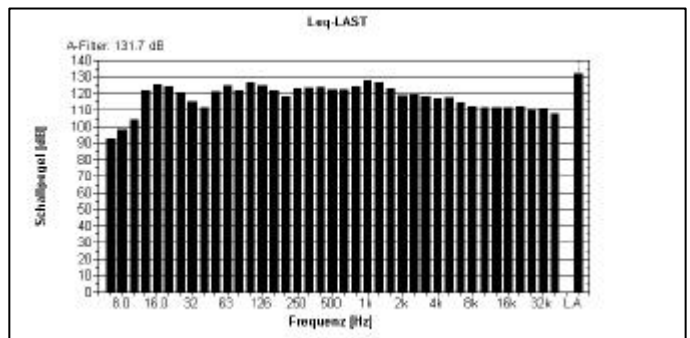


Fig. 4b: Driver airbag (for driver, windows open)

2.4 Results of measurements on lateral airbags

For our measurements on the altogether 10 side airbags used in the test, we found that it was particularly important to insulate the microphones against vibrations, since the airbags came into contact with both the dummy and the seat. High-speed video recordings confirmed that these shocks had an influence on earlier measurements, and we were able to avoid this in subsequent tests.

Thanks to the aspect of symmetry, results can be shown in mirror-image form (window side = "outside" ear, centre of vehicle interior = "inside" ear).

Table 2 shows the results. Here we have also included the SEL readings in dB(C) to indicate the (minor) amount of lower frequencies.

Level =>	L(Peak)	SEL	SEL
Measurement point	dB(C)	dB(A)	dB(C)
Outside ear (window)	158	126	129
Inside ear (centre of car)	153	123	127
SUVA threshold	(140)	125	-

Table 2: Side airbags for both dummies

Therefore for both dummies the readings obtained for lateral airbags are just about equivalent to the levels laid down by SUVA with respect to hearing damage due to impulse noise.

References

Hohmann, Beat W.: Gehörgefährdung durch Airbags (Hazard to hearing due to airbags); Proceedings of the DAGA 98 conference, Zürich; DEGA, Oldenburg

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