

# 13

## NVH Measures

*NVH measures for optimization were determined and their mass was estimated for the ULSAB-AVC vehicle concepts.*

### 13.1 BACKGROUND

In the ULSAB-AVC Program, the basis for good NVH characteristics for the vehicles has been established by surpassing the global mode targets as shown in Chapter 10 - CAE Analysis Results. The next step for NVH optimization was to determine the measures and their mass to achieve good NVH performance overall. The body structure design concepts and the package (location of engine, exhaust, etc..) were reviewed and the measures to be taken were specified using engineering judgement.

The areas of optimization were identified as:

- Airborne noise absorption
- Anti-booming measures
- Bypass noise sealing
- Interior components

### 13.2. Airborne Noise Absorption

Measures taken for absorption of airborne noise emitted from components such as engine, transmission, and other sources are shown in Table 13.2-1, which describes the absorption locations and estimation of mass for these measures for both C-Class and PNGV-Class vehicles.

**Table 13.2-1 Airborne Noise Absorption**

Airborne Noise Absorption Material Location	C-Class (kg)	PNGV-Class (kg)	Material Specification
<b>Damping Powertrain Compartment</b>			Polyurethane light weight foam with water repellent felt surface
Firewall outside	0.50	0.50	
Firewall side LH/RH	0.20	0.20	
Tunnel (outside)	1.10	1.10	
<b>Damping Passenger Compartment</b>			polyester fiber fleece, approx. 20-30 mm
Firewall inner	4.80	4.80	
Doors LH/RH	0.40	0.70	
Quarter Panel rear LH/RH	0.28	0.34	
Wheelhouse inner LH/RH	1.40	1.40	
Liftgate	0.46	n/a	
<b>Insulation</b>			Heavy layer with polyurethane foam
Tunnel	5.00	5.00	

**13.2.1. Absorption with Interior Components**

For additional absorption of airborne noise, the interior materials have been identified with their mass in Table 13.2.1-1.

**Table 13.2.1-1 Airborne noise with interior components**

Airborne Noise Absorption Interior Materials Identification	C-Class (kg)	PNGV-Class (kg)	Material Specification
Floor carpets	15.00	16.00	full absorbing carpet with foam, approx. 30 mm
Floor covering luggage compartment	2.50	4.00	
Roofliner	1.80	1.60	multi-layer molding

**13.3. Anti-booming Measures**

Anti-booming measures are necessary to stabilize the vibrations of membrane surfaces inside the passenger compartment. The material specified for these applications is bituminous hot-melt attenuation foil. Table 13.3-1 shows the material location and estimation of mass.

**Table 13.3-1 Anti-Booming Measures**

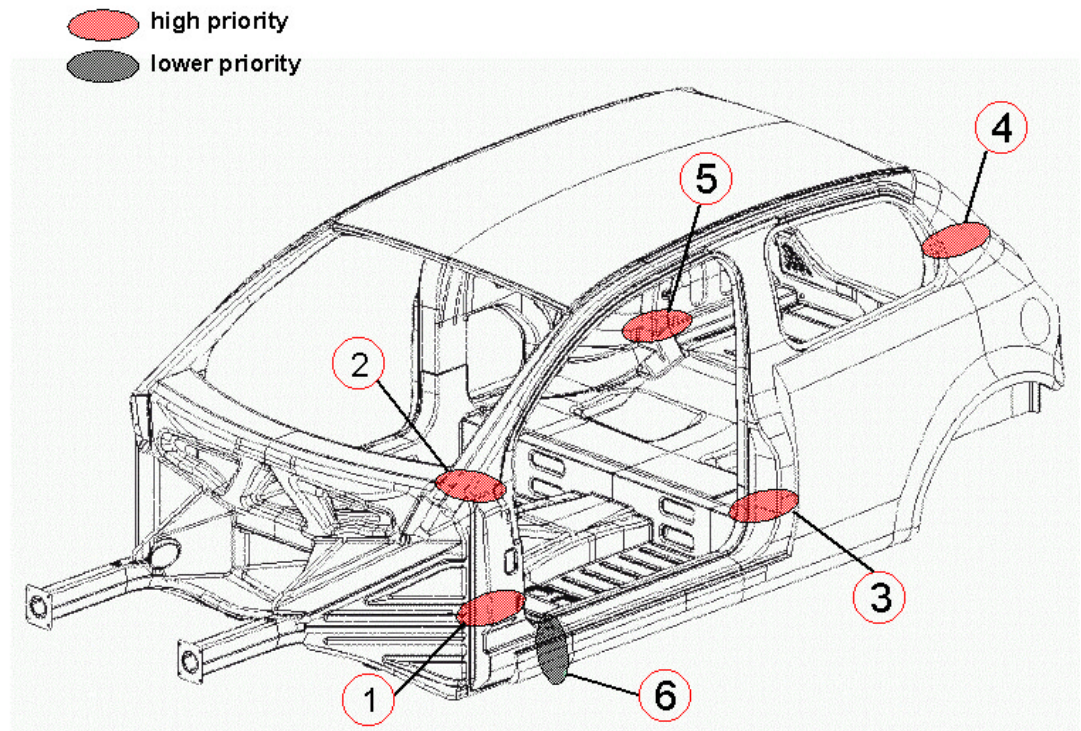
Anti-Booming Material Location	C-Class (kg)	PNGV-Class (kg)	Material Specification
Floor front LH/RH	0.60	0.60	Bituminous hot-melt attenuation foil
Tunnel left and right	0.60	0.60	
Doors LH/RH	0.40	0.70	
Wheelhouse rear LH/RH	0.40	0.40	
Firewall LH/RH	0.60	0.60	

### 13.4 Bypass Noise Sealing



Bypass sealing is applied to prevent noise transmission (road noise, wind, engine noise) into the passenger compartment through hollow structures. The materials specified for this are molded parts with heat-activated expanding foam. The heat is applied during the paint cycle. Table 13.4-1 describes the locations and estimation of mass. The locations (high and low priority) for ULSAB-AVC C-Class vehicle and PNGV-Class vehicle bypass noise sealing materials are shown in Figure 13.4-1 and 13.4-2 respectively.

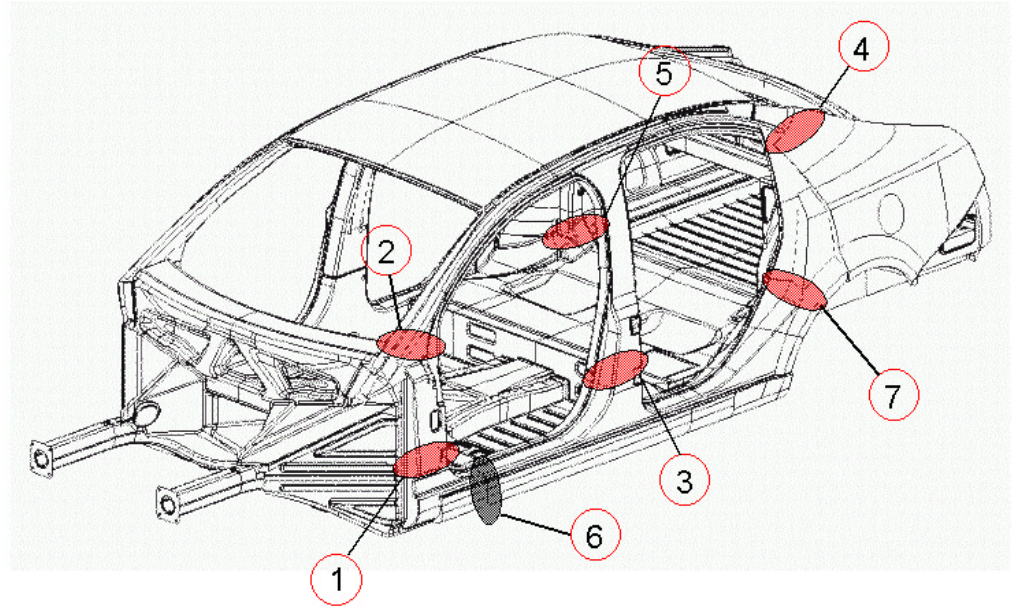
**Table 13.4-1 Bypass Noise Sealing**

Index	Bypass Noise Sealing Location	C-Class (kg)	PNGV-Class (kg)	Material Specification
1	Hinge Pillar lower LH/RH	0.18	0.18	molded parts with heat-activated expanding foam
2	A-Pillar/Side Roof Rail lower LH/RH	0.12	0.12	
3	B-Pillar lower LH/RH	0.18	0.18	
4	C-Pillar lower LH/RH	0.18	0.18	
5	Side Roof Rail rear lower LH/RH	0.10	0.10	
6	Rocker at transition to Hinge Pillar	0.18	0.18	
7	Rear Rail Transition to Rocker	n/a	0.18	



**Figure 13.4-1 C-Class location of bypass noise sealing material**

 high priority  
 lower priority



**Figure 13.4-2 PNGV-Class locations of bypass noise sealing material**

### 13.5. Projected General Sealing Measures

It is necessary to project general sealing measures for routing of wiring harness, air extraction leak sealing (e.g. sealing of holes, cutouts, absorption behind interior panels), which would be specified in a later development phase. The additional mass, estimated in Table 13.5-1 is based on experience and engineering judgement.

Projected General Sealing Measures	C-Class (kg)	PNGV-Class (kg)
(e.g. air outlet, absorption material behind interior panels, cutouts, sealing of hoses)	1.50	1.50

### 13.6. Material Placement in Body Structure

For each of the above mentioned areas, section cuts (see Figure 13.6-1 through 13.6-5) show the typical location of material applied to the body structure.

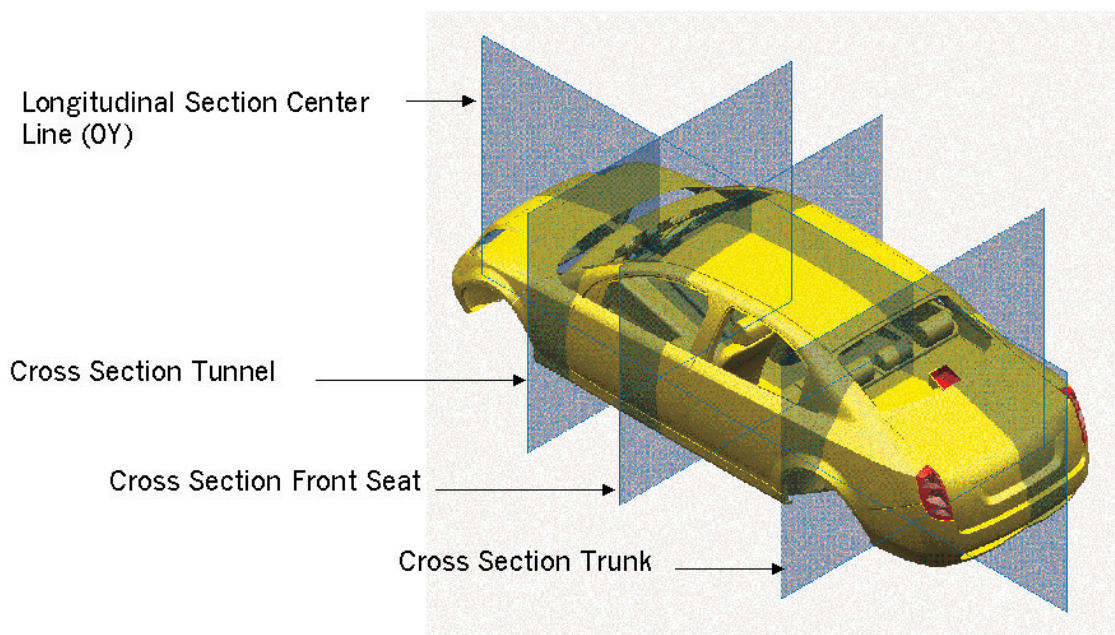


Figure 13.6-1 Section cut locations

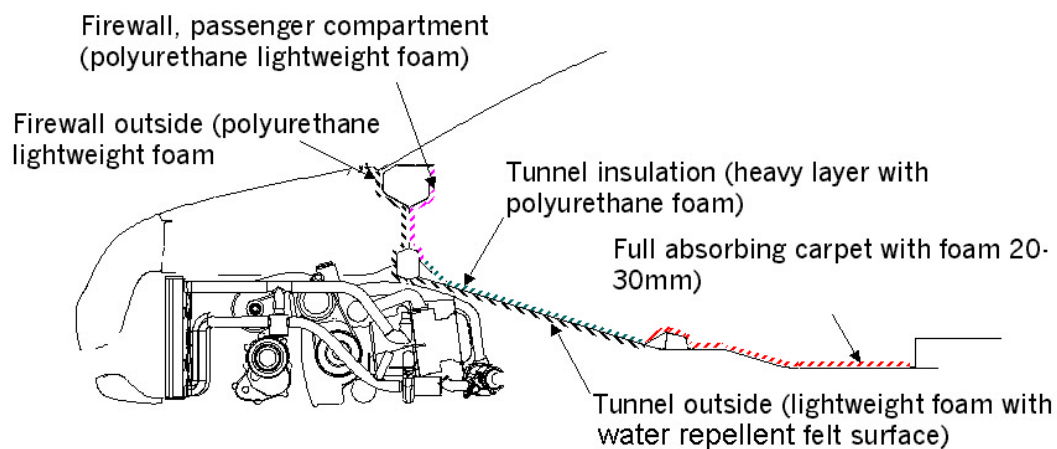


Figure 13.6-2 Longitudinal section center line (OY)

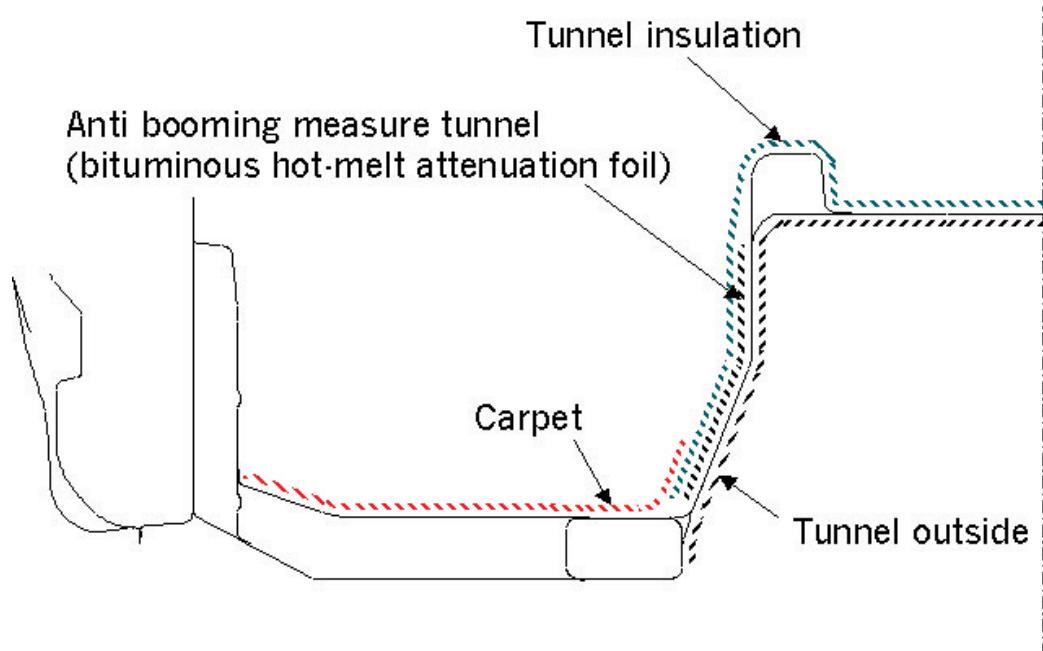


Figure 13.6-3 Cross section tunnel

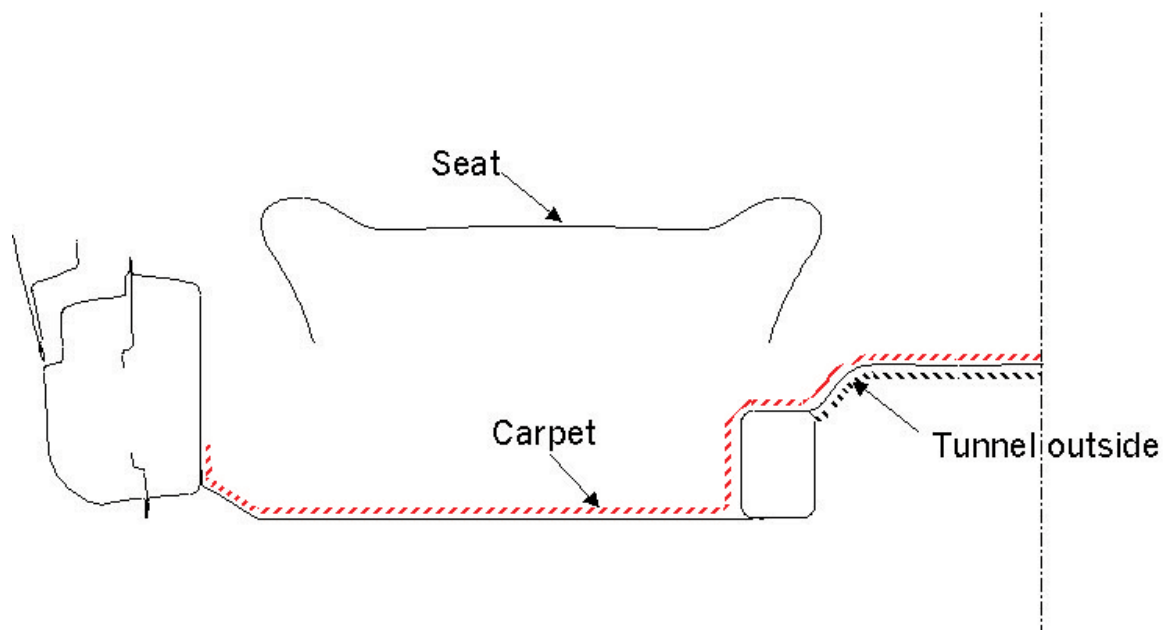


Figure 13.6-4 Cross section front seat

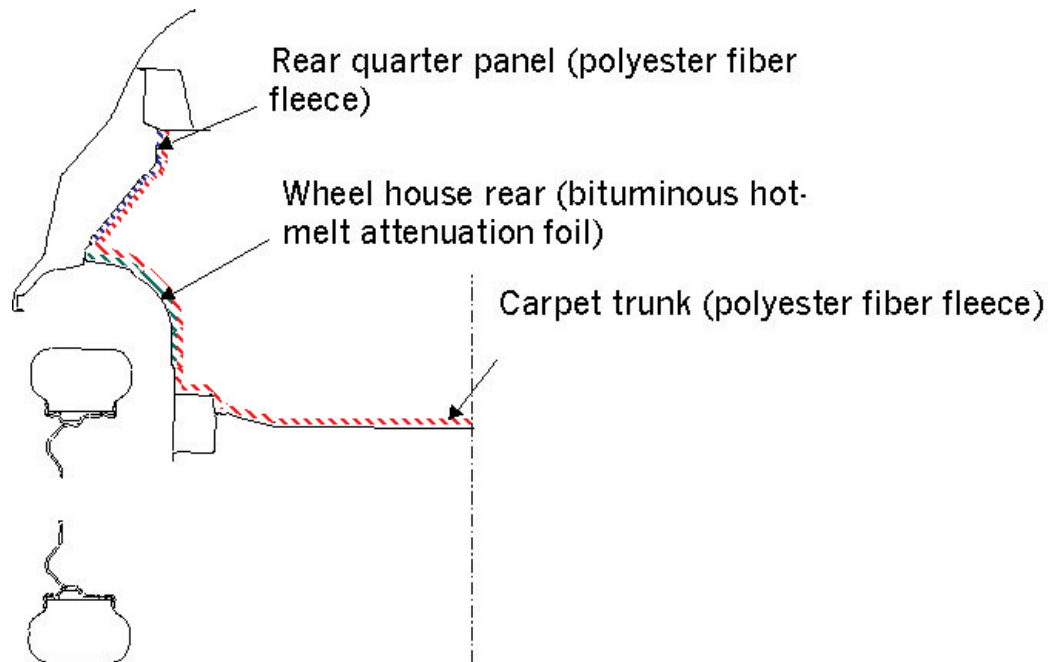


Figure 13.6-5 Cross section trunk

### 13.7. NVH Summary

The measures described are based on the concept designs of both the C-Class and PNGV-Class vehicles and are estimates. They have to be verified or adjusted during vehicle development with physical vehicle testing in a later development phase.

The mass summary for the NVH measures is shown in Table 13.7-1.

Table 13.7-1 NVH mass summary

NVH Measures	C-Class (kg)	PNGV-Class (kg)
Airborne Noise Absorption	14.14	14.04
Anti-Booming Absorption	2.60	2.90
Bypass Noise Sealing	0.94	1.30
Projected General Sealing Measures	1.50	1.50
<b>Total</b>	<b>19.18</b>	<b>19.74</b>

note: interior components mass are not included because they are added into the interior mass