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# 2 ULSAB-AVC Program Targets

*All targets were set based upon Porsche experience, engineering judgement and current, publicly available data, alongside with benchmarking data.*

## 2.1 BACKGROUND

Benchmarking and Target Setting were the ULSAB-AVC Program's first steps in building a foundation and giving direction for work to follow. Benchmarking data provided the information for building the basis of the target setting, after which the program targets were established and guidelines for the design were created.

Benchmarking from current production C-Class and PNGV-Class vehicles, as well as vehicles with a curb mass in the 900 kg range was collected. Additionally, to gather current (production year 1999) and more benchmarking data for component and subsystems, two vehicles were purchased, evaluated and torn down.

The selected vehicles used for this benchmarking purpose:

Ford Focus – C-Class vehicle

Peugeot 206 – B-Class vehicle

The Ford Focus was chosen as a recent example of a production vehicle that meets current safety standards and fits into the C-Class vehicle category size.

**Figure 2.1-1 Ford Focus**

The Peugeot 206 was chosen because its vehicle mass is approximately 909 kg (2000 lb) (basic model without options), but smaller than the Focus. The Peugeot 206 component mass benchmarking provided good examples of component mass that could be used as a guideline for component mass of a lightweight C-Class vehicle concept.

**Figure 2.1-2 Peugeot 206**

For the PNGV-Class vehicle, data from similar sized vehicles (e.g. Audi A6, DaimlerChrysler E-Class) were gathered.

## 2.2 Target Setting Approach

The targets for the ULSAB-AVC Program have been set on the basis of the following assumptions.

- Design will highlight the safety advantages of steel
- Design utilizes advanced steels and manufacturing processes, which are estimated technically feasible in the year 2004
- Design should be capable of high volume manufacturing
- Design in steel for main components will maintain affordability of steel

Various factors had to be taken into consideration during the establishment of targets. First, the program targets were prioritized in the following order:

- Meet anticipated safety requirements for the year 2004
- Mass reduction of main components in steel and to aid achievement of emissions requirements
- Mass reduction of complete vehicle
- Cost is the final priority, the goal was to minimize cost increase

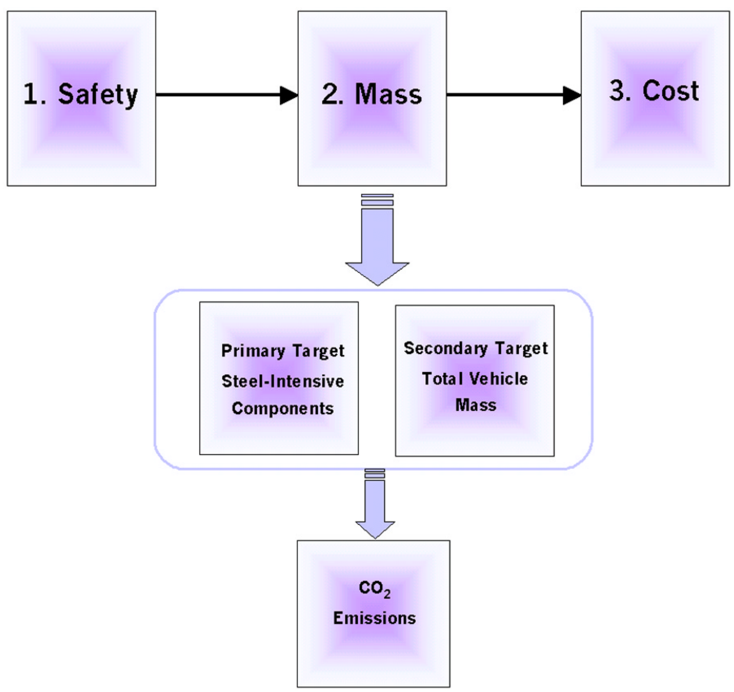



**Figure 2.2-1 Target prioritization**

All targets have been set based upon Porsche experience, engineering judgement and current, publicly available data, alongside the benchmarking data. Targets set for mass, static performance, frequencies and crashworthiness are based on assumptions made with today's knowledge. Targets for exhaust emissions are based on future emission requirements.

## 2.3. Main Component Material Specifications

The specifications for the ULSAB-AVC Program Main Component Material Specifications are defined by the ULSAB-AVC Consortium as primary targets as shown in Table 2.3-1. These specifications reflect the program's goals to develop steel-intensive vehicle concepts.

**Table 2.3-1 Main Component Material Specifications**

| Main Component | Material Specified for ULSAB-AVC |
|---|---|
| Body Structure | Steel Only |
| Closures Structure | Steel Only |
| Chassis | Steel Only |
| Wheels | Steel Only |
| Fuel Tank | Steel Only |
| Interior Structure | Steel and/or alternative materials |
| Other Components | Not specified |

## 2.4. Targets for Crashworthiness

The selected crash events for ULSAB-AVC take into account developments in crashworthiness beyond those considered during the previous UltraLight Steel Auto Body (ULSAB) Program and anticipate future requirements.

Other considerations taken into account during the target setting phase included:

- What is necessary to cover most crash requirements?
- What are the expected requirements in 2004, also taking into account the constant rise in requirement's severity over the last few years?
- What would be credible for presentation to other OEMs for a concept study?
- What can be done under the given time and budget constraints?
- What is used in publications, such as *Auto Motor and Sport,* for crash-worthiness analysis?
- What is needed to document crashworthiness as a basis for Star Ratings?

### 2.4.1. Selected Crashworthiness Events

**Table 2.4.1-1 US-NCAP Front Impact targets**

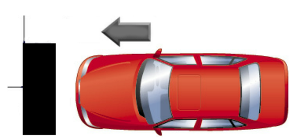
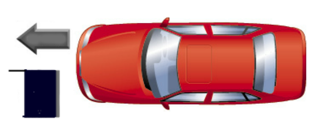
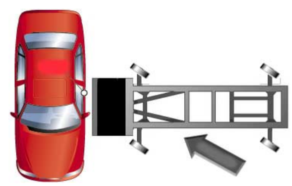
| Crash Event | Crashworthiness Targets |
|---|---|
| US-NCAP Front Impact  | Overall dynamic deformation ≥ 650 mm<br>Steering Column displacement ≤ 80 mm in X-direction |

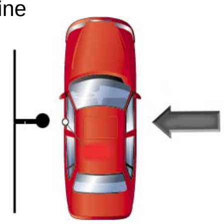
**Table 2.4.1-2 Euro-NCAP Front Impact targets**

| Crash Event | Crashworthiness Targets |
|---|---|
| Euro-NCAP<br>64 km/h (40 mph), 40% overlap offset deformable barrier, zero degree impact  | A-pillar displacement < 50 mm<br>Footwell intrusion < 150 mm<br>Steering column displacement ≤ 80 mm in X-direction |

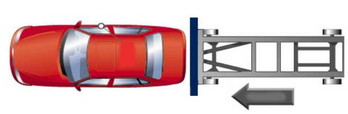
### Table 2.4.1-3 US-SINCAP targets

| Crash Event | Crashworthiness Targets |
|---|---|
| US-SINCAP<br>38.5 mph (61.6 km/h) impact by 1370 kg trolley moving at 63 degrees to longitudinal axis of the vehicle<br> | Maximum intrusion velocity 6-7 m/sec |

### Table 2.4.1-4 Side Pole targets

| Crash Event | Crashworthiness Targets |
|---|---|
| Side Pole Impact<br>32 km/h impact with diameter 254 mm rigid pole aligned with the occupant head Centre of Gravity.<br>Pole extends from 100mm above ground to above vehicle roofline<br> | Maximum Pole Intrusion velocity when striking occupant < 8 m/sec |

### Table 2.4.1-5 Rear Impact targets

| Crash Event | Crashworthiness Targets |
|---|---|
| Rear Impact<br>35 mph (56 km/h) rigid moving barrier 4000lb (1814 kg) impact with rear of vehicle in brakes-off condition<br> | Minimal deformation in region of fuel tank<br>Movement of rear seat R-point < 50 mm |

ULSAB-AVC Program Targets

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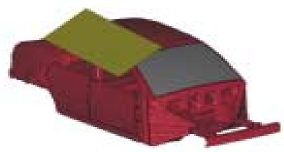
### Table 2.4.1-6 Roof Crush/Rollover targets

| Crash Event | Crashworthiness Targets |
|---|---|
| Roof Crush / Rollover<br><br>An inclined rigid loading device is forced against the A-pillar/roof side structure, quasi-statically, with a load 2.5 times the vehicle weight (27.0 kN)<br>Test similar to FM VSS 216<br> | Roof deformation < 127 mm |

### 2.4.2. Star Rating Assessment

Star Ratings are mainly based on occupant response, which is influenced by restraint system design. The crashworthiness targets have been defined from experience to provide a good basis for achieving a high level of overall safety. The ULSAB-AVC Program provides an optimized lightweight steel structure design concept to be consistent with further automotive design practices that would be used to prepare a complete vehicle for production. ULSAB-AVC concept vehicles, therefore, should provide the opportunity for development of completed vehicles that achieve maximum Star Ratings (4-star EuroNCAP based on 1998 star rating system, 4-5 star US-NCAP) with the use of state of the art occupant restraint system.

## 2.5. Main Component Mass

### 2.5.1. Body Structure Mass

The targets for body structure mass were set with the following assumptions:

- The body structure design will be based on a common platform concept
- The structural elements are designed to take into account the crashworthiness targets using the highest crash mass
- The body structure designs will be based on one specific engine and transmission size envelope

Another important fact to note is the estimated increase in body structure mass in comparison to the ULSAB as a result of more severe crash events in order to achieve the 2004 crashworthiness targets.

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**Table 2.5.1-1 Estimated additional mass to ULSAB body structure due to more severe crash events**

| Added crash events to ULSAB | Estimated additional mass to ULSAB |
|---|---|
| 40% Offset Crash | 7 kg |
| Side Impact | 8 kg |
| Pole Test | 8 kg |
| Roof / Rollover | 2 kg |
| **Total** | **25 kg** |

### 2.5.1.1. C-Class Vehicle Body Structure

The ULSAB body structure was considered as a state of the art optimized steel structure benchmark in the PNGV-Class and no optimized C-Class body structure was available, it is necessary to account for the difference in size and architecture of the two vehicles (C-Class = 3-door hatchback, PNGV-Class = 4-door sedan) when using the ULSAB body structure as a basis for the C-Class body structure mass target setting. Therefore, to determine the mass impact for the different architecture and size, the following formula was used to evaluate the mass reduction for the C-Class vehicle.

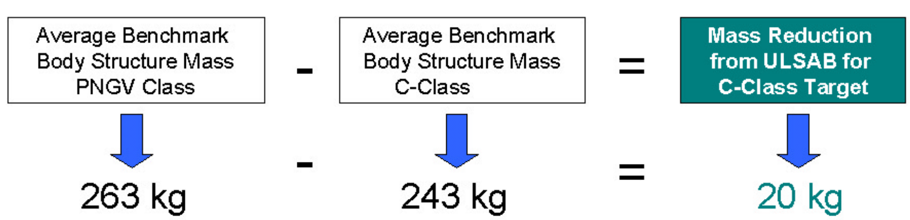


**Figure 2.5.1.1-1 Mass reduction from ULSAB to ULSAB-AVC C-Class vehicle**

The ULSAB-AVC C-Class target is to aim for a 183 kg body structure (ULSAB body structure mass minus the difference of the mass of the body structure of the benchmarked C-Class and PNGV-Class vehicles), while acknowledging that the more severe crash requirements for the year 2004 will cause the body structure mass to increase by an estimated 25 kg. The goal is to offset this mass increase with the application of advanced steel materials, advanced processes, joining technologies and further related innovations.

### 2.5.1.2. PNGV-Class Vehicle Body Structure

The ULSAB-AVC (PNGV-Class) target is to aim for a 203 kg body structure (mass of ULSAB body structure for this vehicle class is "best-in-class"), while acknowledging, that the more severe crash requirements for the year 2004 will cause the body structure mass to increase by an estimated 25 kg. The goal is to offset this mass increase using advanced steel materials, advanced processes, joining technologies and further related innovations.

### 2.5.1.3. C-Class and PNGV-Class Body Structure Targets

**Table 2.5.1.3-1 Body structure mass summary**

| Component Name | C-Class | PNGV-Class |
|---|---|---|
| | Target (kg) | Target (kg) |
| Body-in-White | 183 (+25)* | 203 (+25)* |

** estimated mass increase to ULSAB body structure due to more severe crash events*

### 2.5.2. Closures Mass

The targets set for the ULSAB-AVC closures structures take into account the difference in size of the AVC closures verses the ULSAC closures. The goal is to reach the targets set in the ULSAC Program, which were specified in $kg/m^2$.

The impact in mass for additional reinforcements as needed for increased Side Impact crash energy absorption could not be estimated at the time of target setting and was dependent on the body structure performance in the Side Impact crash event.

**Table 2.5.2-1 C-Class closure structure targets**

| Closure Structure | Benchmarked Best-in-class kg | Target C-Class kg | Target C-Class $kg/m^2$ | Remarks |
|---|---|---|---|---|
| Door Front | 31.0 | 26.0 | 15.5 | * |
| Hood | 13.5 | 16.0 | 8.0 | * |
| Hatch | 11.0 | 10.0 | 14.0 | * |
| Fenders | 6.0 | 4.0 | - | * |
| **Totals** | **61.5** | **56** | | * |

* Targets are based on the ULSAC program, with adjustments for different sizes due to vehicle styling.

**Table 2.5.2-2 C-Class closure assembly parts (e.g. hinges, brackets, etc.)**

| Closure Assembly Parts | Benchmarked Avg. kg | Target C-Class kg | Remarks |
|---|---|---|---|
| Door Front | 9.8 | 8.0 | |
| Hood | 1.5 | 1.0 | Same as PNGV-Class |
| Hatch | 2.6 | 2.5 | |
| Elec. Window Reg. | 4.0 | 4.0 | |
| **Total** | **17.9** | **15.5** | |

**Table 2.5.2-3 C-Class closures summary**

| | Target C-Class kg |
|---|---|
| Structure Closures | 56.0 |
| Assembly Parts | 15.5 |
| **Closures Total** | **71.5** |

### Table 2.5.2-4 PNGV-Class closure structures

| Closure Structure | Benchmarked Best-in-class kg | Target PNGV-Class kg | Target PNGV-Class kg/m$^2$ | Remarks |
|---|---|---|---|---|
| Door Front | 30.0 | 27.0 | 15.5 | * |
| Door Rear | 24.5 | 22.0 | 15.5 | * |
| Hood | 17.0 | 16.0 | 8.0 | * |
| Deck Lid | 11.0 | 10.0 | 8.0 | * |
| Fenders | 6.7 | 4.0 | - | * |
| **Total** | **89.2** | **79.0** | | * |

* Targets are based on the ULSAC program, with adjustments for different sizes due to vehicle styling

### Table 2.5.2-5 PNGV-Class closure assembly parts (e.g. hinges, brackets, etc.)

| Closure Assembly Parts | Benchmarked Avg. kg | Target PNGV-Class kg | Remarks |
|---|---|---|---|
| Door Front | 9.6 | 8.0 | |
| Door Rear | 5.7 | 4.0 | |
| Hood | 3.6 | 1.0 | Same as C-Class |
| Deck Lid | 4.4 | 4.0 | |
| Elec. Window Reg. | 8.0 | 8.0 | |
| **Total** | **31.3** | **25.0** | |

**Table 2.5.2-6 PNGV-Class closure summary**

| | Target PNGV-Class kg |
|---|---|
| Closure Structures | 79.0 |
| Closure Assembly | 25.0 |
| **Closure Total** | **104.0** |

### 2.5.3. Glazing

The target setting is based upon the average C-Class and the average PNGV-Class. These targets should be achievable with the use of reduced glass thickness for the rear glass (approx. 20%). No further reduction of glass thickness is foreseen at this time due to NVH reasons.

**Table 2.5.3-1 Glazing targets**

| Component Name | Avg. C-Class kg | Avg. PNGV-Class kg | C-Class Target kg | PNGV-Class Target kg |
|---|---|---|---|---|
| Front | 12.3 | 12.3 | 12.3 | 12.3 |
| *Side 2 Door | 15.0 | - | 15.0 | - |
| **Side 4 Door | - | 14.7 | - | 14.7 |
| Rear | 6.0 | 7.3 | 4.8 | 5.8 |
| **Total** | **33.3** | **34.3** | **32.1** | **32.8** |

* Front door and rear quarter
** Front and rear door

### 2.5.4. Chassis and Suspension

**Table 2.5.4-1 Chassis targets**

| Component Name | Avg. Peugeot & Focus kg | C-Class Target kg | PNGV-Class Target kg | Remarks |
|---|---|---|---|---|
| Front Suspension ind. Subframe | 54.5 | 50.0 | 50.0 | |
| Rear Suspension incl. Subframe | 48.3 | 42.0 | 42.0 | |
| Pedals<br>Main Brake Cylinder<br>Parking Brake<br>Gear Shift | 7.7 | 5.7 | 5.7 | Approx. -25% |
| Wheels (4) | 31.5 | 20.0 | 20.0 | Size 6x15 in steel (w/steel co. tech) 5 kg each |
| Tires (4) | 26.2 | 26.2 | 26.2 | Size 165/65 R15 |
| Brake System hydraulic/ABS | 9.2 | 8.5 | 8.5 | Approx.-10% |
| Steering incl. Power System | 17.6 | 16.0 | 16.0 | Approx. -10% |
| Front Brake System | 17.0 | 15.5 | 15.5 | Approx. -10% |
| Rear Brake System | 16.0 | 14.5 | 14.5 | Approx. -10% |
| **Total** | **228.0** | **198.5** | **198.5** | |

### 2.5.5. Engine

**Table 2.5.5-1 Engine targets**

| Component Name | Avg. Peugeot & Focus kg | C-Class Target kg | PNGV-Class Target kg | Remarks |
|---|---|---|---|---|
| Engine Gasoline | 105.8 | 100.0 | 100.0 | |
| Engine Diesel | - | (135) | (135) | |
| Cooling System | 8.5 | 8.0 | 8.0 | Fan & Radiator |
| Fuel Pump | 2.6 | 2.6 | 2.6 | Carryover Part – Focus |
| Fuel Tank incl. Filler | 8.0 | 10.0 | 10.0 | 40 L – Steel |
| Fuel System | 3.5 | 3.5 | 3.5 | Assembly |
| Exhaust System incl. Catalytic Converter (gasoline) | 14.6 | 15.0 | 16.0 | Heavier catalytic converter for lower emissions |
| Exhaust System Diesel | | (20) | (21) | |
| Active Carbon Filter | 0.75 | 0.75 | 0.75 | |
| Heat Shield Exhaust System | 2.63 | 2.5 | 2.5 | |
| Engine Electrical Control unit | 1.8 | 1.0 | 1.0 | |
| **Total Gasoline** | **148.2** | **143.5** | **144.5** | |
| **Total Diesel** | **-** | **183.5** | **184.5** | |

### 2.5.6. Transmission

**Table 2.5.6-1 Transmission targets**

| Component Name | Avg. Peugeot & Focus kg | C-Class Target kg | PNGV-Class Target kg | Remarks |
|---|---|---|---|---|
| Transmission | 52.35 | 40.0 | 40.0 | Semi-automatic |
| Drive Shafts | 11.8 | 10.0 | 10.0 | |
| **Total** | **64.15** | **50.0** | **50.0** | |

### 2.5.7. Interior

The targets set for interior are based on the average C-Class and PNGV-Class vehicles. It is assumed that the same dash panel is used for both vehicle concepts. Heating ventilation and air-conditioning systems will be the same for both classes. Due to engine package and platform strategy (same front end), the PNGV-Class system will be used for C-Class.

**Table 2.5.7-1 Interior targets**

| Component Name | Avg. B-marked C-Class kg | Avg. B-marked PNGV-Class kg | C-Class Target kg | PNGV-Class Target kg | Remarks |
|---|---|---|---|---|---|
| Carpets<br>Instrument Panel<br>Restraint system<br>Interior Panels | 68.0 | 79.0 | 65.0 | 73.0 | |
| Seat system F & R | 63.0 | 69.0 | 63.0 | 69.0 | |
| Heating & Ventilation | 11.5 | 15.5 | 14.0 | 14.0 | Carryover Part PNGV-Class |
| Sound Damping | 16.6 | 20.0 | 16.6 | 20.0 | |
| Air Conditioning | 13.8 | 16.2 | 16.2 | 16.2 | Carryover Part PNGV-Class |
| **Total** | **173.0** | **199.7** | **174.8** | **192.2** | |

### 2.5.8. Exterior Trim

**Table 2.5.8-1 Exterior trim targets**

| Component Name | Peugeot 206 kg | Ford Focus kg | C-Class Target kg | PNGV-Class Target kg |
|---|---|---|---|---|
| Exterior | 4.9 | 9.9 | **4.5** | **6.5** |

### 2.5.9. Electrics

**Table 2.5.9-1 Electrics targets**

| Component Name | Avg. C-Class kg | Avg. PNGV-Class kg | C-Class Target kg | PNGV-Class Target kg |
|---|---|---|---|---|
| Windshield Wipers (Front & Rear) | 6.0 | 3.8 | 6.0 | 3.8 |
| Lights (Front & Rear) | 7.6 | 9.7 | 7.5 | 7.5 |
| Electrics & Cables | 15.1 | 19.5 | 13.0 | 15.0 |
| Batteries (36 AH/LV) | 12.3 | 18.5 | 12.3 | 12.3 |
| Radio (2 speakers & antenna) | 2.9 | 2.9 | 2.9 | 2.9 |
| **Total** | **43.9** | **54.4** | **41.7** | **41.5** |

### 2.5.10. Automotive Fluids

Fuel tank fuel capacity (40 L) is based on 600 km range at maximum fuel consumption plus four-liter reserve. Engine oil capacity is increased to account for the dry sump lubrication system that was anticipated for a new engine package.

**Table 2.5.10-1 Automotive fluid targets**

| Component Name | Peugeot 206 kg | Ford Focus kg | C-Class Target kg | PNGV-Class Target kg |
|---|---|---|---|---|
| Oil | 3 | 2.9 | 5.0 | 5.0 |
| Coolant | 6.5 | 5.1 | 5.0 | 5.0 |
| 36 L Gasoline* | 39.5 | 41.8 | 27.0 | 27.0 |
| 36 L Diesel* | | | 30.0 | 30.0 |
| Gear Oil | 1.9 | 1.6 | 2.5 | 2.5 |
| Washing Fluid | 2.9 | 3.2 | 1.5 | 1.5 |
| **Total Diesel** | | | 44.0 | 44.0 |
| **Total Gasoline** | **53.8** | **54.6** | **41.0** | **41.0** |

* 90% fuel in 40 L tank. Specific average mass of gasoline = 0.75 kg/L
Specific average mass of Diesel = 0.84 kg/L

### 2.5.11. Main Component Mass Summary

The total vehicle is the sum of the mass of all components. The two vehicle mass targets are base upon:

- C-Class vehicle – 3-door hatch (overall length = 4100 ± 100 mm)
- PNGV-Class vehicle – 4-door sedan (overall length = 4750 mm)

### Table 2.5.11-1 Main component mass target summary

| Component Name | C-Class | | PNGV-Class | |
|---|---|---|---|---|
| | Diesel kg | Gasoline kg | Diesel kg | Gasoline kg |
| Body Structure Mass | | 183(+25)* | | 203(+25)* |
| Closures | | 71.5 | | 104.0 |
| Glazing | | 32.1 | | 32.8 |
| Chassis | | 198.5 | | 198.5 |
| Engine | 183.5 | 143.5 | 184.5 | 144.5 |
| Transmission | | 50.0 | | 50.0 |
| Interior | | 173.0 | | 192.0 |
| Exterior | | 4.5 | | 6.5 |
| Electrics | | 41.7 | | 41.5 |
| Automotive Fluid | 44.0 | 41.0 | 44.0 | 41.0 |
| Paint | | 16.0 | | 20.0 |
| **Total** | **998(+25)*** | **955(+25)*** | **1077(+25)*** | **1034(+25)*** |

** estimated mass increase due to ULSAB body structure due to more severe crash events*

### Table 2.5.11-2 Total vehicle mass target

| | C-Class | | PNGV-Class | |
|---|---|---|---|---|
| | Diesel kg | Gasoline kg | Diesel kg | Gasoline kg |
| Total Vehicle Mass | 998(+25)* | 955(+25)* | 1077(+25)* | 1034(+25)* |
| Benchmarking Vehicle | NA | 1147 (Focus) | NA | 1470 PNGV-Class ref. vehicle |
| Difference | | -192(+25)* | | -436(+25)* |

** estimated mass increase to ULSAB body structure due to more severe crash events*

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## 2.6. Structural Performances – Body Structure

The structural performance for C-Class are based on benchmarking results. The benchmarking results show lower rigidity figures for hatchback vehicles compared to a 4-door sedan due to their lack of cross car connection in the package tray area. The performance targets for C-Class are set with priority to mass reduction, not for maximum stiffness.

The structural performance targets for the PNGV-Class vehicle reference ULSAB benchmarking data and are set the same as they were for ULSAB.

**Table 2.6-1 Body structure rigidity**

| Performance | C-Class | PNGV-Class |
|---|---|---|
| Static Bending Rigidity (N/mm) | 11,000 | 12,000 |
| Static Torsion Rigidity (Nm/deg) | 12,000 | 13,000 |

* Body structure with glass

**Table 2.6-2 Body structure frequencies**

| Frequencies* | C-Class Target | PNGV-Class Target |
|---|---|---|
| First Global Mode (Hz) | ≥35 | ≥40 |
| First Global Mode Torsion (Hz) | ≥35 | ≥40 |
| First Global Mode Bending (Hz) | ≥48 | ≥48 |
| Local Mode Lateral Front End (Hz) | ≥55 | ≥55 |

* Body structure without glass

## 2.7. Emissions

The $CO_2$ emissions are directly related to a vehicle's fuel consumption and the fuel type used (i.e. gasoline or diesel). The 2004 EUCAR specified the $CO_2$ emissions for a fleet average of 140 g/km.

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The target for fuel consumption relates directly to the target for $CO_2$ emissions. The $CO_2$ emissions-related fuel consumption is different for gasoline and Diesel-powered vehicles. For ULSAB-AVC, the $CO_2$ EUCAR Fleet Average target is adopted as a single vehicle target that will comply with future requirements.

The PNGV-Class target for exhaust emissions refers to the EPA tier 2 requirements. This requirement is a fleet average and for that reason it is considered as a target for the ULSAB-AVC Program. The European EU4 requirements are single values for one vehicle and will therefore, be the emission target for ULSAB-AVC. It is assumed that achieving the EU4 Exhaust Emissions Targets also fulfill the EPA Tier 2 Requirements. The overall emission scope of work for the ULSAB-AVC Program is to fulfill the limited values of EU4. These values will be required in Europe by the year 2005

Current technologies on the market do not provide solutions to achieve these targets with vehicles using gasoline or diesel powered engines. For vehicles using gasoline-powered engines, auto OEMs are confident that solutions to achieve the targets can be developed by the year 2005.

For vehicles using diesel-powered engines, solutions to achieve the targets are only possible if low sulfur diesel fuel (approx. 10 ppm) will then be available and if the development of the catalytic converter/particle filter technology will progress as assumed today.

It is unlikely that other options, such as hydrogen fuel cells, will be sufficiently ready for volume production within the required timeframe. Due to the wide variety and generally propriety nature of hybrid propulsion systems, internal combustion engines were selected rather than hybrid options.

**Table 2.7-1 Emissions limited values for EU4**

| Emission Limited Values for EU4 (g/km) | CO | HC | NOx | (HC+NOx) | PM |
|---|---|---|---|---|---|
| Gasoline Engine | 1.0 | 0.1 | 0.08 | -- | -- |
| Diesel Engine | 0.5 | -- | 0.25 | 0.3 | 0.025 |

## 2.8. Vehicle Dimensions

The vehicle dimensions have been set to achieve a good basis for a platform concept that complies with the dimension as set by PNGV. In order to give the design some flexibility, these secondary targets have a tolerance range.

The wheelbase for the C-Class vehicle is not specified because the goal is to achieve maximum interior volume at a given vehicle length range. The wheelbase for PNGV-Class is given at a minimum length for the same reason.

### Table 2.8-1 Vehicle dimension targets

| SAE Index | Exterior | C-Class | PNGV-Class | Comments |
|---|---|---|---|---|
| L103 | Overall Length/mm | 4100(±100) | 4750 | |
| W103 | Overall Width/mm | 1750(±50) | 1822(±50) | |
| H100 | Overall Height/mm | 1400(±50) | 1374 | at curb weight |
| W101 | Track - Front/mm | 1530(±20) | 1529(±20) | |
| W102 | Track - Rear/mm | 1530(±20) | 1529(±20) | |
| L101 | Wheelbase/mm | TBD | ≥ 2743 | C-Class, depends on package |
| | Frontal Area/m2 | ≤ 2.0 | ≤ 2.0 | |
| W3 | Shoulder Room Front/mm | 1402 | 1402 | |
| | Shoulder Room Rear/mm | ≥ 1350 | 1389 | Avg. C-Class |
| W4 | Interior Volume/m3 | ≥ VW GolfV | 2.7 | |
| | Track Volume/m3 | ≥ VW GolfV | 0.44 | |
| | Passenger Capacity | 5.0 | 5.0 | |
| | Turning Circle/m | ≤ 11 | TBD | * |

*PNGV-Class depnding on wheelbase, same front suspension layout as C-Class

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## 2.9. Vehicle Performances

Vehicle performance targets were set based on engineering judgement to achieve the primary program objectives. The performance targets had to reflect customer driven trends.

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**Table 2.9-1 Vehicle performance targets**

| Main Performance | C-Class Target | PNGV-Class Target |
|---|---|---|
| Acceleration (0-100 km/h)/sec | ≤ 14 | ≤ 14 |
| Aerodynamic Drag coefficient | ≤ 0.25 | ≤ 0.25 |
| Top Speed Continuous/kmh | 160 | 160 |

## 2.10. Standard and Optional Equipment

The definition of the standard vehicle equipment was made with the intent of reflecting the customer's expectation in most markets of the world. Optional equipment will add mass to the total vehicle mass and must be considered in the calculation of crash mass (see Chapter 10 – CAE Analysis Results).

Table 2.10-1 Standard equipment

| Equipment | C-Class | PNGV-Class |
|---|---|---|
| **Safety** | | |
| 2 Airbags Front | X | X |
| 2 Airbags Rear | X | X |
| 2 Seatbelts Front | X | X |
| 3 Seatbelts Rear | X | X |
| ABS | X | X |
| First Aid Kit | X | X |
| **Comfort** | | |
| Power Locks | X | X |
| Power Windows | X | X |
| Air Conditioning | X | X |
| Radio with 2 speakers | X | X |
| Anti-theft Device | X | X |

### Table 2.10-2 Optional equipment

| Equipment | Mass Impact (kg) |
|---|---|
| **Optional** | |
| Sound System | 2.5 |
| Bigger Wheels and Tires | 15.0 |
| Navigation System | 2.0 |
| Sun/Moon Roof | 20.0 |
| Electrical Seat Adjustment | 10.0 |
| **Total Options** | **49.5** |