AGENCY SPONSORED MASS REDUCTION STUDIES FOR THE MIDTERM EVALUATION

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US EPA  
US DOT
LD GHG MYs 2017+ CO₂ and Fuel Economy Targets (Based on Footprint)

**EPA (2017-2025): CO₂ (g/mile)**

Cars

Trucks

**NHTSA (2017-2021): Fuel Economy (mpg)**

Cars

Trucks

Increasing Stringency

Increasing Stringency
## Timing for Mid Term Evaluation (MTE)

<table>
<thead>
<tr>
<th>Schedule</th>
<th>Milestone in the Midterm Evaluation Process</th>
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<tbody>
<tr>
<td>June 2016</td>
<td>EPA, NHTSA and CARB jointly issue a <strong>Draft Technical Assessment Report (TAR)</strong> for public comment</td>
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<tr>
<td>Between the Draft TAR</td>
<td>EPA issues for public comment a Proposed Determination on the appropriateness of the MYs 2022-2025 standards</td>
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<tr>
<td>and Final Determination</td>
<td>NHTSA (potentially jointly with EPA) issues a Notice of Proposed Rulemaking</td>
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<tr>
<td>No later than April</td>
<td>EPA issues a <strong>Final Determination</strong> on the appropriateness of the 2022-2025 standards</td>
</tr>
<tr>
<td>2018</td>
<td></td>
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</table>

The Draft Technical Assessment Report (TAR) is the first step in the process, to seek public comment that will inform decisions regarding standards for MYs 2022-2025 – it is a technical report, not a decision document.
What factors will we consider for the Midterm Evaluation?

- Powertrain improvements
- Light-weighting and impacts on vehicle safety
- Market penetration of fuel efficient technologies
- Consumer acceptance
- Payback periods for consumers
- Fuel prices
- Fleet mix
- Infrastructure
- Employment impacts
- Any others …
• Cost and feasibility estimates were not based on any single study
• Wide range of sources considered, and aggregated into a cost curve
Agency Sponsored Holistic Vehicle Mass Reduction Studies

Since then, the agencies have sponsored several mass reduction projects for unibody designed passenger cars and CUVs and body-on-frame designed pickup trucks.

- **(EPA) Midsize CUV** (2012):
  - Baseline: MY2010 Venza
  - Unibody
  - Towing 1000-3500 lbs
  - 2G Optimization; Secondary Mass
  - HSS body structure with limited use of Al closure

- **(ARB) Midsize CUV** (2012):
  - Baseline: MY2010 Venza
  - Unibody
  - Towing 1000-3500 lbs
  - Al intensive design

  - Baseline: MY2011 Silverado
  - Body on Frame
  - Towing up to 12,000 lbs
  - 2G Optimization; Secondary Mass
  - Al intensive and HSS frame

  - Baseline: MY2011 Honda Accord
  - Unibody
  - Towing 1000 lbs
  - 3G Optimization
  - AHSS body structure with Al Closure

  - Baseline: MY2014 Silverado
  - Body on Frame
  - Towing up to 12,000 lbs
  - 3G Optimization
  - AHSS frame with Al/AHSS cab structure and closure
Scope of Study:
- Base Truck: 2011 Silverado 1500, Crew Cab, 4x4
- Methodology: Similar to EPA’s Midsize CUV 2012
- Contractor: FEV w/Subcontractors EDAG, Munro, etc.
- Addition of Dynamic and Durability Analyses
  - Dynamic: instrument vehicle and run on test track
  - Bed and frame durability (CAE) under loaded conditions

Boundary Conditions
- Maintain function and performance (including payload and towing capacities) (2011)
- No degradation in safety from the baseline vehicle (2011)
- Capable of being mass produced in the 2020-2025 timeframe (450,000/yr)
- 10% maximum increase in direct manufacturing costs

Report Status: Post Peer Review - Online April ‘15 – EPA Website
CAE was used for a variety of analyses, including:

- NVH (frame, box, cabin, body on frame)
- Crash and Safety (FMVSS, IIHS)
- Durability and Full Vehicle Dynamics
Preliminary results (peer review revisions pending)

- Results are a range of possible mass reduction – not a single point
- Multiple body and frame solutions included
- Some cost savings at low levels of mass reduction (from this base vehicle)
EPA Sponsored Light Duty Pickup Truck Lightweighting Study
- Non body and frame mass reduction examples with cost savings

**Material and Design Optimization**
- C-70 vs. PM Connecting Rods

**Material and Design Substitution**
- DuPont™ Vespel® SP-21 Thrust Washer vs. roller bearings

**Material Processing**
- PolyOne & Mucell Applications

**Material Substitution**
- Thermoplastic Vulcanizates (TPV) vs. EPDM, Static and Dynamic Weather Seals (Jyco)

**Material and Part Consolidation**
- Passenger Side Airbag Housings (DSM)

**Design and Processing**
- ½ Shafts - Vari-lite® tube process (U.S. Manufacturing Corporation)
• **Purpose:** Design a light-weighted light-duty pickup truck that can
  – At minimum, meet the following performance functions of original baseline vehicle:
    • Safety
    • NVH
    • Fuel Economy, Utility/Performance (towing, acceleration)
    • Manufacturability
    • Durability
    • Serviceability, etc.
  – Control both direct and in-direct cost to maintain affordability
    • Maintain retail price parity of +/- 10% of baseline vehicle
  – Use advanced design, material and manufacturing process for MYs 2020-2030
  – Recommendation for cost curve for both passenger car and light truck:
    Single curve? Multiple curves? How to generalize the mass reduction amount and cost to the overall fleet?
  – Mass reduction for other light-duty vehicles
The work under this contract will occur in two phases and divided into three major parts as follows:

- Phase I - Baseline Vehicle Tear-down and Finite Element Analysis Modeling
- The Contractor shall pick a baseline vehicle that best represents the Contractor’s expectation of the light-duty pickup truck fleet for MY 2021 and perform a teardown study to build the baselines for engineering analysis and cost analysis for the lightweighted design.
The work under this contract will occur in two phases and divided into three major parts as follows:

- Phase II, Part 1 - Design and Optimization of the Light-Weighted Pickup Truck and Cost Modeling
- The Contractor shall use advanced design, material and manufacturing processes that will likely be available during model years 2020-2030 to develop a light-weighted pickup truck concept vehicle that is capable of high volume production.
The work under this contract will occur in two phases and divided into three major parts as follows:
- Phase II, Part 2 - Mass Reduction for Other Light-Duty Vehicles
  - Generalize the results from the midsize passenger car lightweighting project and pickup truck lightweighting project to other vehicle classes, such as small PC, large PC, CUV, and other size of pickup trucks.
• Baseline vehicle is also the latest design at the beginning of the project with extensive use of AHSS, 5 star safety rating and lowest mass compared with other MY 2014 light duty trucks.

• Tear down and investigate a total of 3 vehicles
  – Fully understand the impact on light-weighting from different body styles, powertrain combinations, driveline variations and towing/payload packages.

• Use 3G optimization
  – Redesign of structure to accommodate the usage of new materials, new manufacturing processes and joining processes.
  – Seek to identify maximum potential mass reduction for the vehicle structure (cab, box, closures and frame)

• Integrate all the most recent safety tests including IIHS small overlap test and have the test fully integrated into the light-weighted design.

• Investigate mass reduction for other vehicle classes
<table>
<thead>
<tr>
<th>Final Rules by FMVSS No.</th>
<th>Passenger Cars Added Weight (kg)</th>
<th>Light Trucks Added Weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>111 Rear Cameras</td>
<td>0.19</td>
<td>0.15</td>
</tr>
<tr>
<td>214 Side Pole</td>
<td>5.64</td>
<td>5.25</td>
</tr>
<tr>
<td>216 Roof Crush</td>
<td>5.28</td>
<td>5.28</td>
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<tr>
<td>226 Ejection Mitigation</td>
<td>0.91</td>
<td>1.07</td>
</tr>
<tr>
<td><strong>Final Rules Subtotal</strong></td>
<td><strong>12.02</strong></td>
<td><strong>11.75</strong></td>
</tr>
</tbody>
</table>

## Estimated Vehicle Weight Impact of Safety Regulations – Potential Rules

<table>
<thead>
<tr>
<th>Potential Rules</th>
<th>Passenger Cars Added Weight (kg)</th>
<th>Light Trucks Added Weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>min</td>
<td>max</td>
</tr>
<tr>
<td>Pedestrian Protection</td>
<td>??</td>
<td>??</td>
</tr>
<tr>
<td>Forward Collision Warning (with Dynamic Brake Support and Crash Imminent Braking)</td>
<td>0.29</td>
<td>2.72</td>
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<tr>
<td>Lane Departure Warning</td>
<td>Included above</td>
<td>Included above</td>
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<tr>
<td>Part 563 EDR</td>
<td>0.04</td>
<td></td>
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<tr>
<td>V2V</td>
<td>1.56</td>
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<tr>
<td><strong>Potential Rules Subtotal</strong></td>
<td>10.96</td>
<td>20.87</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>22.98</td>
<td>32.89</td>
</tr>
</tbody>
</table>
Conclusions

• Over the past 5 years, the agencies (NHTSA, EPA and ARB) have invested millions of dollars into advancing our understandings of mass reduction cost, feasibility, and safety:
  • These studies covered both unibody and body-on-frame design, from passenger cars to crossover utility vehicles to pickup trucks;

• These studies helped the agencies better understand the engineering principles, material usages, design and manufacturing complexity and cost of mass reduction;

• These studies laid solid foundation for the inputs for rulemaking analyses for midterm review;

• These studies (CAE models and cost models) are in public domain and helpful to foster more studies in understanding mass reduction and its costs.
EXTRA SLIDES
EPA Sponsored Light Duty Pickup Truck Lightweighting Study
- Project Methodology Overview
(Source: FEV)

**Finger Print Baseline Technology**

1. Measure
2. Record
3. Reproduce
4. Analyze

**Teardown and Idea Generation**

5. Evaluate
6. Generate

**Mass-Reduction and Cost Optimization Process**

7. Estimate
8. Score
9. Select

**Detailed Mass-Reduction Feasibility and Cost Analysis**

10. Calculate
11. Analyze

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*Note: The table and diagrams illustrate the project methodology overview, including steps such as measurement, record-keeping, idea generation, and detailed analysis of mass reduction and cost optimization.*