

f. Number of valves per cylinder (*e.g.*, 2, 3, 4).

g. Valvetrain Design (*e.g.*, overhead valve, overhead camshaft,

h. Valve technology (*e.g.*, variable valve timing, variable valve lift and timing, intake valve throttling, camless valve actuation, etc.)

i. Horsepower and torque ratings,

j. Models in which engines are to be used, giving the introduction model year for each model if different from "a," above.

5. Relative to MY 2003 levels, for MYs 2005–2012, please provide information, by model and as an average effect on a manufacturer's entire passenger car fleet, on the weight and/or fuel economy impacts of the following standards or equipment:

a. Federal Motor Vehicle Safety Standard (FMVSS 208) Automatic Restraints

b. FMVSS 201 Occupant Protection in Interior Impact

c. Voluntary installation of safety equipment (*e.g.*, antilock brakes)

d. Environmental Protection Agency regulations

e. California Air Resources Board requirements

f. Other applicable motor vehicle regulations affecting fuel economy.

6. For each of the model years 2003–2012, and for each passenger car model projected to be manufactured by respondent (if answers differ for the various models), provide the requested information on new technology applications for each of items "6a" through "6r" listed below:

(i) description of the nature of the technological improvement;

(ii) the percent fuel economy improvement averaged over the model;

(iii) the basis for your answer to 6(ii), (*e.g.*, data from dynamometer tests conducted by respondent, engineering analysis, computer simulation, reports of test by others);

(iv) the percent production implementation rate and the reasons limiting the implementation rate;

(v) a description of the 2003 baseline technologies and the 2003 implementation rate; and

(vi) the reasons for differing answers you provide to items (ii) and (iv) for different models in each model year. Include as a part of your answer to 6(ii) and 6(iv) a tabular presentation, a sample portion of which is shown in Table III-A.

a. Improved automatic transmissions. Projections of percent fuel economy improvements should include benefits of lock-up or bypassed torque converters, electronic control of shift points and torque converter lock-up, and other measures which should be described.

b. Improved manual transmissions. Projections of percent of fuel economy improvement should include the benefits of increasing mechanical efficiency, using improved transmission lubricants, and other measures (specify).

c. Overdrive transmissions. If not covered in "a" or "b" above, project the percentage of fuel economy improvement attributable to overdrive transmissions (integral or auxiliary gear boxes), two-speed axles, or other similar devices intended to increase the range of available gear ratios. Describe the devices to

be used and the application by model, engine, axle ratio, etc.

d. Use of engine crankcase lubricants of lower viscosity or with additives to improve friction characteristics or accelerate engine break-in, or otherwise improved lubricants to lower engine friction horsepower. When describing the 2003 baseline, specify the viscosity of and any fuel economy-improving additives used in the factory-fill lubricants.

e. Reduction of engine parasitic losses through improvement of engine-driven accessories or accessory drives. Typical engine-driven accessories include water pump, cooling fan, alternator, power steering pump, air conditioning compressor, and vacuum pump.

f. Reduction of tire rolling losses, through changes in inflation pressure, use of materials or constructions with less hysteresis, geometry changes (*e.g.*, reduced aspect ratio), reduction in sidewall and tread deflection, and other methods. When describing the 2003 baseline, include a description of the tire types used and the percent usage rate of each type.

g. Reduction in other driveline losses, including losses in the non-powered wheels, the differential assembly, wheel bearings, universal joints, brake drag losses, use of improved lubricants in the differential and wheel bearing, and optimizing suspension geometry (*e.g.*, to minimize tire scrubbing loss).

h. Reduction of aerodynamic drag.

i. Turbocharging or supercharging.

j. Improvements in the efficiency of 4-cycle spark ignition engines including (1) increased compression ratio; (2) leaner air-to-fuel ratio; (3) revised combustion chamber configuration; (4) fuel injection; (5) electronic fuel metering; (6) interactive electronic control of engine operating parameters (spark advance, exhaust gas recirculation, air-to-fuel ratio); (8) variable valve timing or valve lift; (9) multiple valves per cylinder; (10) cylinder disablement; (11) friction reduction by means such as low tension piston rings and roller cam followers; (12) higher temperature operation; and (13) other methods (specify).

k. Gasoline direct injection engines.

l. Naturally aspirated diesel engines, with direct or indirect fuel injection.

m. Turbocharged or supercharged diesel engines with direct or indirect fuel injection.

n. Stratified-charge reciprocating or rotary engines, with direct or indirect fuel injection.

o. Two cycle spark ignition engines.

p. Use of hybrid drivetrains

q. Use of fuel cells; provide a thorough description of the fuel cell technology employed, including fuel type and power output.

r. Other technologies for improving fuel economy or efficiency.

7. For each model of respondent's passenger car fleet, projected to be manufactured in each of MYs 2003–2012, describe the methods used to achieve reductions in average test weight. For each specified model year and model, describe the extent to which each of the following methods for reducing vehicle weight will be used.

a. Substitution of materials.

b. "Downsizing" of existing vehicle design to reduce weight while maintaining interior

roominess and comfort for passengers, and utility, *i.e.*, the same or approximately the same, payload and cargo volume, using the same basic body configuration and driveline layout as current counterparts.

c. Use of new vehicle body configuration concepts, which provides reduced weight for approximately the same payload and cargo volume.

8. Indicate any MY 2004–2012 passenger car model types that have higher average test weights than comparable MY 2003 model types. Describe the reasons for any weight increases (*e.g.*, increased option content, less use of premium materials) and provide supporting justification.

9. For each new or redesigned vehicle identified in response to Question 3 and each new engine or fuel economy improvement identified in your response to Questions 3, 4, 5, and 6, provide your best estimate of the following, in terms of constant 2003 dollars:

(a) Total capital costs required to implement the new/redesigned model or improvement according to the implementation schedules specified in your response. Subdivide the capital costs into tooling, facilities, launch, and engineering costs.

(b) The maximum production capacity, expressed in units of capacity per year, associated with the capital expenditure in (a) above. Specify the number of production shifts on which your response is based and define "maximum capacity" as used in your answer.

(c) The actual capacity that is planned to be used each year for each new/redesigned model or fuel economy improvement.

(d) The increase in variable costs per affected unit, based on the production volume specified in (b) above.

(e) The equivalent retail price increase per affected vehicle for each new/redesigned model or improvement. Provide an example describing methodology used to determine the equivalent retail price increase.

10. Please provide respondent's actual and projected U.S. passenger car sales, for each model year from 2003 to 2012, inclusive. Please subdivide the data into the following vehicle categories:

i. Two-Seater Car (*e.g.*, Chevrolet Corvette, Ford Thunderbird, Honda Insight)

ii. Mini-compact Car (*e.g.*, Audi TT Coupe, Lexus SC 300/430, Mitsubishi Eclipse Spyder)

iii. Subcompact Car (*e.g.*, Ford Mustang, Toyota Celica, Volkswagen New Beetle)

iv. Compact Car (*e.g.*, Chevrolet Cobalt, Dodge Neon, Ford Focus)

v. Midsize Car (*e.g.*, Chevrolet Malibu,

Dodge Stratus, Honda Accord, Toyota Camry)

vi. Large Car (*e.g.*, Chevrolet Impala, Dodge Intrepid, Ford Crown Victoria)

vii. Small Station Wagon (*e.g.*, BMW 325 Sport Wagon, Subaru Impreza Wagon, Volkswagen Jetta Wagon)

viii. Midsize Station Wagon (*e.g.*, Ford

Taurus Wagon, Saab 9–5 Wagon, Subaru

Legacy Wagon)

See Table III-B for a sample format.

11. Please provide your estimates of projected *total industry* U.S. passenger car sales for each model year from 2003 through 2012, inclusive. Please subdivide the data