Regulatory Impact Analysis
(Final Rule)

Federal Test Procedure Revisions

August 15, 1996

U.S. Environmental Protection Agency

Office of Air and Radiation

Office of Mobile Sources

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1. Introduction

Under Executive Order 12866,[1] the Agency must determine whether the regulatory action is "significant" and therefore subject to review by the Office of Management and Budget (OMB) and the requirements of the Executive Order. The Order defines "significant regulatory action" as one that is likely to result in a rule that may:

> (1) have an annual effect on the economy of $100 million or more or adversely affect in a material way the economy, a sector of the economy, productivity, competition, jobs, the environment, public health or safety, or State, local, or tribal governments or communities;
> (2) create a serious inconsistency or otherwise interfere with an action taken or planned by another agency;
> (3) materially alter the budgetary impact of entitlements, grants, user fees, or loan programs or the rights and obligations of recipients thereof; or,
> (4) raise novel legal or policy issues arising out of legal mandates, the President's priorities, or the principles set forth in the Executive Order.

Section 202 of the Unfunded Mandates Reform Act of 1995 (‘Unfunded Mandates Act’, UMRA) (signed into law on March 22, 1995) requires that the Agency prepare a budgetary impact statement before promulgating a rule that includes a Federal mandate that may result in expenditure by State, local, and

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[1] 58 FR 51735, October 4, 1993.

tribal governments, in the aggregate, or by the private sector, of $100 million or more in any one year. The budgetary impact statement must include: (i) identification of the Federal law under which the rule is promulgated; (ii) a qualitative and quantitative assessment of anticipated costs and benefits of the Federal mandate and an analysis of the extent to which such costs to State, local, and tribal governments may be paid with Federal financial assistance; (iii) if feasible, estimates of the future compliance costs and any disproportionate budgetary effects of the mandate; (iv) if feasible, estimates of the effect on the national economy; and (v) a description of the Agency's prior consultation with elected representatives of State, local and tribal governments and a summary and evaluation of the comments and concerns presented. Section 203 provides that if any small governments may be significantly or uniquely impacted by the rule, the Agency must establish a plan for obtaining input from and informing, educating, and advising any such potentially affected small governments.

Under section 205 of the Unfunded Mandates Act, the Agency must identify and consider a reasonable number of regulatory alternatives before promulgating a rule for which a budgetary impact statement must be prepared. The Agency must select from those alternatives the least costly, most cost-effective, or least burdensome alternative, for State, local, and tribal governments and the private sector, that achieves the objectives of the rule, unless the Agency explains why this alternative is not selected or unless the selection of this alternative is inconsistent with law.

Pursuant to the terms of Executive Order 12866 and UMRA, it has been determined that this rule is a "significant regulatory action" because compliance with the proposed regulations could have an annual effect on State, local, and tribal governments in aggregate, or the private sector of over $100 million per year. As such, this document contains a detailed qulitative and quantitative analysis of potential costs and benefits of this rulemaking action and was submitted to OMB for review. Changes made in response to OMB suggestions or recommendations will be documented in the public record.

The Environmental Protection Agency (EPA) is proposing that passenger cars and light trucks be tested for compliance with emission standards over a new test procedure. The proposed test procedure does not replace existing test procedures, but rather adds to them. Associated with the additional testing burden are costs of compliance, development, and vehicle modifications, resulting in associated emission reductions. The proposed regulations are applicable to all light-duty vehicles and light-duty trucks starting with the 2000 model year (2002 for light-duty trucks over 6000 GVWR).

This RIA briefly addresses the air quality problems and needs within the United States. However, the primary purpose of this RIA is to present the Agency's cost, emission reduction, and cost effectiveness estimates associated with the proposed regulations and the various regulatory and control options considered. Detailed discussion of the proposed requirements, the options considered, and technological feasibility upon which this RIA are based can be found in the preamble and supporting documents contained in the public docket for this rulemaking.

2. Statement of Needs and Consequences

The cornerstone of the Clean Air Act is the effort to attain and maintain National Ambient Air Quality Standards (NAAQS). Regulation of emissions from on-highway, area, and stationary sources prior to enactment of the Clean Air Act Amendments (CAAA) of 1990 has resulted in significant emission reductions from these sources. However, many air quality regions have failed to attain the NAAQS, particularly for ozone and carbon monoxide (CO). This is due to many factors, including the number of vehicles on the road and a corresponding increase in the number of miles driven by the in-use fleet which, even though single vehicles have experienced significant emission reductions, has worked to offset the total emission reductions from the motor vehicle fleet.

2.1. Urban Air Pollution

Automobiles are a well known major source of volatile organic compounds (VOC) and oxides of nitrogen (NOx), both of which are precursors of ground level ozone, or smog. Motor vehicles are also a major source of CO emissions. While significant progress has been made over the past two decades in controlling automobile emissions, as of August 1994, 93 air quality control regions still failed to meet the national ambient air quality standard (NAAQS) for ozone, and 36 regions failed to attain the NAAQS for CO.[2]

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40 CFR Part 81.

The Revised FTP final rule is promulgated under section 202, 206, 208 and 301 of the Clean Air Act and its Amendments (CAA and Act respectively). Specifically, section 206(h) of the Act requires that EPA review its regulations for the testing of motor vehicles and revise them if necessary to ensure that motor vehicles are tested under circumstances reflecting actual current driving conditions. The Agency completed this review process and published its findings in May of 1993.[3] As a result of that review effort, the Agency determined that it is necessary to revise the existing test procedures to ensure that motor vehicles are indeed tested under circumstances reflecting actual current driving conditions. Further detail on the inadequacy of the current test procedures, and how the proposed test procedures address these inadequacies, can be found in the NPRM on this rulemaking.[4]

2.1.1. Ozone

Ozone is a powerful oxidant which affects humans by irritating the respiratory system and reducing lung function. Ozone has been shown to cause symptoms such as cough, headache, chest pains, sore throat, and eye irritation, which may restrict normal daily activities. In addition to temporary symptoms, laboratory studies suggest that ozone may also permanently damage lung and other tissues. The ozone precursor NO_2 has also been

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EPA, Office of Air and Radiation, *Federal Test Procedure Review Project: Preliminary Technical Report*, 420-R-93-007, May 1993.

[4] 59 FR 7404 (February 7, 1995)

shown to increase the frequency of respiratory infection.[5]

Ozone also affects plants and materials. Oxidation by ozone can impair plant tissue function and reduce the yield of some crops. Some tree species suffer injury to needles or leaves, lowered productivity, and in severe cases, individual trees can die.[6] Tropospheric ozone, or ozone existing in the lower atmosphere, also contributes to the greenhouse effect.[7]

2.1.2. Carbon Monoxide

The primary effect on humans of elevated ambient CO levels is a decrease in the ability of blood to carry oxygen throughout the body. It may also reduce the ability of muscle tissue to store oxygen for use during sudden exertion. In general, under high levels of ambient CO, these mechanisms will tend to exacerbate cardiovascular stress, leading to a decrease in maximum exercise time in healthy persons and decreased time to angina attacks in angina patients. High ambient levels of CO also have deleterious effects on the central nervous system, decreasing vigilance, visual perception, manual dexterity, learning ability, and the ability to perform complex tasks. Fetuses and newborns may be especially sensitive to the presence

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Jane Hall, et.al, "Economic Assessment of Health Benefits from Improvements in Air Quality in the South Coast Air Basin," a report to the South Coast Air Quality Management District, June 1989.

U.S. Congress, Office of Technology Assessment, *Catching Our Breath: Next Steps for Reducing Urban Ozone*, 1989.

Schneider, Stephen, *Global Warming* (San Francisco: Sierra Club) 1989.

of CO in the blood; even exposures to moderate levels of CO may produce deleterious effects on the fetus such as reduced birth weight and increased newborn mortality.[8]

2.2. Sources of Ozone and CO

2.2.1. Ozone

Ozone is produced in the troposphere by photochemical reactions of non-methane volatile organic compounds (VOCs) and oxides of nitrogen (NOx). Most studies indicate that reductions of both VOC and NOx will lead to reductions of ozone, except under specific circumstances.[9,10] A National Academy of Sciences Study[11] states that, "Control of NOx......, although it is predicted to lead to an increase in ozone in some places, such as downtown Los Angeles and New York City......will probably be necessary in addition to or instead of VOC control to alleviate the ozone problem in many cities and regions." Even under those circumstances where a NOx decrease can result in an ozone increase, the ozone increase occurs only until a "ridgeling" is reached, after which further NOx control results in reduced ozone

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EPA, Office of Air Quality, Planning and Standards, *Regulatory Impact and Analysis of the National Ambient Air Quality Standards for Carbon Monoxide*, EPA 450/5-85-007, June 1985.

Rethinking the Ozone Problem in Urban and Regional Air Pollution, National Research Council, 1991.

B.J. Finlayson-Pitts and J.N. Pitts, Jr., "Atmospheric Chemistry of Tropospheric Ozone Formation: Scientific and Regulatory Implications," *Air and Waste*, Vol. 43, August 1993.

Rethinking the Ozone Problem in Urban and Regional Air Pollution, National Research Council, 1991.

concentrations. In areas with relatively high VOC/NOx ratios, typical of suburban and rural areas, decreasing NOx concentrations at constant VOC concentrations is very effective in ozone reduction.[12]

The precursors to ozone and ozone itself are transported long distances under some commonly occurring meteorological conditions. Specifically, concentrations of ozone and its precursors in a region and the transport of ozone and precursor pollutants into, out of, and within a region are very significant factors in the accumulation of ozone in any given area. Regional transport may occur within a state or across one or more state boundaries. Local stationary source NOx and/or VOC controls are key parts of the overall attainment strategy for non-attainment areas. However, the ability for an area to achieve ozone attainment and thereby reduce ozone-related health and environmental effects is often heavily influenced by the ozone and/or precursor emission levels of upwind areas. Thus for many of these areas, attainment of the ozone NAAQS will require control programs much broader than strictly locally-focused controls in order to take into account the effect of emissions and ozone far beyond the boundaries of the actual non-attainment area.

For this reason, effective ozone control requires an integrated strategy which combines cost-effective reductions in

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B.J. Finlayson-Pitts and J.N. Pitts, Jr., "Atmospheric Chemistry of Tropospheric Ozone Formation: Scientific and Regulatory Implications," *Air and Waste*, Vol. 43, August 1993.

emissions from both mobile and stationary sources at the local, state, regional and national levels.

Unless properly designed and maintained, motor vehicles can emit significant amounts of VOCs through both fuel evaporation and exhaust emissions. Gasoline itself is a VOC. Current-technology vehicles capture evaporative emissions in a charcoal canister which must be periodically purged into the intake manifold and burned in the combustion process. Exhaust VOCs are reduced by reducing crevice areas in the combustion chamber, improved fuel mixing, and catalytic after-treatment, among other measures.

Oxides of nitrogen (NOx) are formed in the combustion chamber when oxygen and atmospheric nitrogen combine at high temperatures. NOx emissions are traditionally reduced by lowering peak combustion temperatures through exhaust gas recirculation or through other measures, and by catalytic exhaust after-treatment.

Motor vehicles are estimated to contribute approximately 25% of VOC emissions nationally and 36% of VOC emissions in urban areas.[13] Small "area sources" such as bakeries, dry cleaners and consumer solvents contribute 25% and large point sources such as petroleum refineries contribute 10% of VOC emissions nationwide.[14] Motor vehicles also contribute significantly to

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EPA, *Nonroad Engine and Vehicle Emission Study -- Report*, 21A-2001, November 1991.

ibid.

NOx, with an estimated contribution of roughly 29% nationally and 33% in some urban areas.[15] Nonroad sources, including construction and farming equipment contribute roughly 15% nationally.[16]

2.2.2. Carbon Monoxide

Carbon monoxide is created when a carbon-based fuel is burned with air. Gasoline is a mixture of various hydrocarbon compounds. When burned with sufficient oxygen, gasoline combustion produces carbon dioxide (CO_2) and water (H_2O). However, when burned with insufficient oxygen, some of the carbon will form CO.

Ambient CO exceedances occur primarily in the winter, due to inversion layers and increased CO generation from motor vehicles during cold starts. Motor vehicles are by far the most significant source of CO in urban areas. In CO non-attainment areas, motor vehicles typically account for 42% of wintertime CO emissions nationally, and as high as 80% in some urban areas during the winter months.[17] Other sources of CO are residential fuel use and nonroad engines, including construction and farm equipment and recreational equipment. These numbers indicate the importance of CO controls on motor vehicles.

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ibid.

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2.3 Consequences of the Proposed Action

This action finalizes additions and revisions to the tailpipe emission portions of the Federal Test Procedure (FTP) for light-duty vehicles (LDVs) and light-duty trucks (LDTs). The primary new element of the rulemaking is a Supplemental Federal Test Procedure (SFTP) designed to address shortcomings with the current FTP in the representation of aggressive (high speed and/or high acceleration) driving behavior, rapid speed fluctuations, driving behavior following startup, and use of air conditioning. An element of the SFTP that also affects the conventional FTP is a new set of requirements designed to more accurately reflect real road forces on the test dynamometer. The Agency is also finalizing new emissions standards for the new control areas with a specified phase-in period for these standards. After complete fleet turnover, the standards final today are estimated to reduce emissions from LDVs and LDTs by 2.4 percent for non-methane hydrocarbons (NMHC), 11.1 percent for carbon monoxide (CO), and 9.2 percent for oxides of nitrogen (NOx).

Incorporating off cycle emissions related to A/C and Aggressive driving behavior into the Federal Test Procedures will help to close the discrepancy between MOBILE model predictions and air quality monitors. This will allow the EPA and other agencies the ability to more accurately predict and analyze air quality.

As stated above, the SFTP test cycle changes and their respective standards will cause a significant reduction in NMHC, CO and NOx. The economic consequences on the Manufacturers from the SFTP include increased testing, facilities and hardware burdens and costs. The environmental and economic impacts of the SFTP rule are discussed in more detail in this document.

3. Environmental Impact

3.1. Methodology

The methodology used to estimate the emission reductions associated with the proposed federal test procedure revisions was to determine the expected lifetime emission reductions per vehicle sold after implementation of the proposed regulations.

3.2. Baseline Emissions

Several test programs were conducted to evaluate actual in-use driving patterns,[18] and various test cycles were developed in an effort to determine the emissions of typical vehicles under such driving conditions. Baseline emissions for this analysis are taken from the extensive test programs conducted by the Agency and the original equipment manufacturers in support of the FTP Review Project. The weighted averages of the emission results of these test vehicles over the various test procedures developed constitute the baseline emissions used in this analysis.

3.3. Emission Reductions

The emission reductions used in this analysis were calculated by subtracting the achievable level of control for each control area from the baseline test vehicle emissions.

EPA, *Federal Test Procedure Review Project: Preliminary Technical Report,* 420-R-93-007, May 1993.

These test vehicle reductions were then weight averaged in an attempt to simulate the reductions associated with the actual in-use vehicle fleet mix. It should be noted that these test results were derived for a properly operating vehicle with a 50K mile catalyst and do not include any allowance for the higher emission levels that typically occur in use due to additional deterioration beyond 50k miles and malfunctions. Thus, the emission benefits calculated here are likely to be significantly understated.

The average emission factor reduction per vehicle during typical ozone exceedance days associated with the proposed regulations, as discussed in the Response to Comments, are shown in Table 3.1.

Table 3.1
Average Emission Factor Reduction Per Vehicle
During Typical Ozone Exceedances

Control Area	NMHC (g/mi)	CO (g/mi)	NOx (g/mi)
US06	0.024	1.5	0.073
Air Conditioning	0.00	0.00	0.054

It should be noted that the estimates in Table 3.1, as well as all of the emission benefit calculations in support of this Final Rule, are based upon data from properly operating vehicles with 50k deteriorated components. Data from in-use testing, such as incorporated by the MOBILE model, indicate that average in-use emissions are much higher, due to the disproportionate impact of vehicles with malfunctions or higher deterioration. While EPA did not have any data to assess the impact of malfunctions and higher deterioration on the off-cycle emission inventory or the emission reductions associated with this rule, it is virtually certain that the higher in-use baseline emissions will translate into larger emission benefits from control of off-cycle emissions, perhaps by a factor of two or more. This means that the emission benefit calculations in support of this rule are likely to be extremely conservative.

The emission reduction numbers in Table 3.1 constitute the emission reductions associated with the proposed requirements in g/mi during typical ozone exceedance days. These g/mi values were then multiplied by the average annual mileage accumulation rates to determine the average annual emission reductions per year in each vehicle's life.

It should also be noted that no attempt was made to account for the lower air conditioning usage during the rest of the year. The impact of air conditioning on emissions differs from most emission factors in that it has a disproportionate impact during typical ozone exceedances. To properly compare the cost effectiveness of controlling air conditioning emissions to other emission factors that are more consistent year around, it is necessary to use methodologies that target typical ozone exceedances.

In order to target typical ozone exceedances, Table 3.1 includes a factor to account for compressor "on" time versus "off" time for A/C. That is, even with the A/C turned "on," the compressor is not always operating, and it is the compressor's operation that actually causes an increase in vehicle emissions. Therefore, emission reductions will be realized only during compressor operation. Agency test data suggests that the compressor "on" time is roughly 52 percent of the total drive time during typical ozone exceedances. Therefore, a 52 percent factor was included in the air conditioning emission factor reduction listed in Table 3.1.

Multiplying these numbers by a discount rate of 7% and survival rates from the MOBILE model results in the estimaed annual emission reduction per vehicle.[19] Adding these estimated annual reductions over an estimated lifetime of the vehicle results in the estimated lifetime emission reduction per vehicle. Spreadsheet calculations of these lifetime emission reductions are shown in Appendix A, with the results shown in Table 3.2.

Discounting transforms future costs and benefits into their "present values," that is, into what they are worth today. Direct comparisons between costs and benefits then can be made to determine whether a particular regulation appears to be justified. A discount rate of 7% has been used throughout this analysis.

Table 3.2
Vehicle Lifetime Emission Reductions
Pounds Per Vehicle

Control Area	NMHC	CO	NOx
US06	4.4	277	13.5
Air Conditioning	0.0	0.0	10.0
Total	4.4	277	23.5

Using the emission factor reductions shown in Table 3.1, it is possible to estimate the tons per summer day emission reductions in various years as a result of the proposed test procedure modifications. This was done using estimates taken from the Agency's Fuel Consumption Model of vehicle miles traveled (VMT)[20] for different model year vehicles during each year of interest. These annual VMT estimates were first divided by 365 to get the daily VMT, and were then multiplied by 1.05 to account for a slightly higher VMT during summer months. These results were then multiplied by the emission factor reductions shown in Table 3.1 for all model years during which the proposed test procedure changes will result in emission reductions. During the 2000 through 2002 model year phase-in period for LDV and Light LDT, and the 2002 through 2004 model year phase in period for Heavy LDT, the results have been multiplied by factors

Tables of the VMT estimates by model year used in these calculations can be found in Appendix B.

of 0.36, 0.64, and 0.80, respectively, to reflect the 40-80-100 percent phase-in of US06 and A/C requirements, and the 80 percent contribution of US06 and A/C controls to the overall program. These calculations are shown in Appendix B for model years 2005, 2010, 2015, and 2020, and are summarized in Table 3.3. The percent reduction columns in Table 3.3 compare these estimated ton per summer day emission reductions to the baseline emissions for the light duty fleet (cars and trucks).

Table 3.3
Fleet Emission Reductions
Tons/Summer Day and % Reduction in Light-Duty Fleet Emissions

	NMHC		CO		NOx	
Year	tpsd	%	tpsd	%	tpsd	%
2005	89	1.0	5573	5.3	472	4.2
2010	158	1.8	9869	8.7	836	7.2
2015	207	2.2	12950	10.5	1097	8.7
2020	236	2.4	14739	11.1	1249	9.3

The percentage emission reductions shown in Table 3.3 were calculated by first adding the off-cycle g/mi emission increases to the current MOBILE5a emission factors, assuming national averages and summer temperatures, and including the effects of Phase II reformulated gasoline, the presence of an enhanced inspection and maintenance program, revised evaporative emission test procedures, and Tier I emission standards. The addition of the off-cycle emission increases to the current MOBILE5a emission factors represents the true baseline fleet emission factors. These baselines were then compared to the off-cycle emission factors after control of high speed/transient emissions and emissions during A/C operation. The MOBILE5a outputs and the calculations of reductions in light-duty fleet emission factors are shown in Appendix C for model years 2005, 2010, 2015, and 2020.

4. Economic Impact

The proposed additions to emission test procedures will impose several costs on the original equipment manufacturers. These costs include added hardware and associated tooling costs for improved emission control, development, and redesign costs, improved engine control calibrations, and increased costs associated with the certification process including durability data vehicle testing and reporting. These costs are analyzed under a stand alone approach to test procedures and emission standards. No attempt has been made to quantify cost reductions assoiciated with the flexibilities allowed by the composite standard. Thus, the cost estimates are almost certainly overstated.

The cost estimates correspond to costs incurred by the manufacturer in complying with the proposed requirements. These costs can be divided into fixed and variable costs. Fixed costs are those costs made prior to vehicle production and are relatively independent of production volumes. The fixed costs considered in this analysis are those for engine control recalibration, vehicle redesign, mechanical integrity testing on redesigned engine families, certification durability demonstration, annual certification costs, tooling costs, and test facility upgrades and construction. Variable costs are costs for the necessary emission control hardware and are, by nature, directly dependent on production volume. The following analysis assumes that each federally certified engine family has roughly a 5 year lifetime, ie., recalibration and redesign efforts are not routinely conducted every year on every engine family, but rather every five years. The analysis also assumes a 10 year lifetime for facility upgrades and an annual sales figure of 15 million vehicles outside the State of California. Spreadsheet calculations of all costs associated with the proposed test procedure changes can be found in Appendix D.

The EPA uses two scenarios in its cost effectiveness analysis (RIA) to calculate test facility costs, the first is for the use of an A/C simulation and the second is for the use of full environmental cells for A/C testing. For the Full Environmental Cell (FEC) A/C scenario the A/C test is assumed to be performed by itself in a full environmental cell and the FTP/USO6 tests performed together in exhaust emission cells. For the A/C Simulation scenario the A/C test is assumed to be performed with the FTP/USO6 test cycles in a standard exhaust emission test cell, with the addition of some testing to demonstrate correlation between FEC and the air conditioning Simulation.

4.1. Recalibration Costs

The Agency assumes that each engine family produced for sale in the U.S. will require some level of engine control recalibration to comply with the proposed test procedures. Assuming that each engine family recalibration effort requires 1 full person-year at $120,000 per person-year (including salary, benefits, etc.) for engine control software reprogramming, and using the current 340 federally certified LDV and LDT engine families, the estimated cost of reprogramming is $40.8 million for both the Simulation and Full Environmental Cell scenario's.

Associated with this recalibration effort will be considerable emission testing over the proposed test procedures to evaluate and verify the recalibration effort. Assuming that each engine family recalibration effort requires an average of 435 emission tests per family (calculated from testing burden information submitted by AAMA/AIAM), assuming that 60 percent of these engine families would have undergone some form of recalibration for reasons unrelated to the proposed test procedure changes (20% each year over the three year phase in period), and using testing costs of $900 for the proposed A/C Simulation scenario, $720 for the A/C FEC scenario and $600 for the current test procedure[21] (note that 60 percent of the families will incur incremental recalibration testing costs of $900 minus $600 for the Simulation and $720 minus $600 for the FEC because they would have been tested under the current test procedure independent of this rulemaking), the estimated testing cost associated with engine recalibration for the Simulation scenario is $79.9 million and for the Full Environmental Cell scenario is $159.9 million ($106.6 million for A/C and $53.3 million for USO6/FTP).

Adding these two costs results in an estimated cost for recalibration for the Simulation scenario of $120.7 million and

[21]Testing costs were calculated using AAMA/AIAM comments on costs per shift and EPA estimates of tests per shift (see RTC for more detailed analysis)

for the Full Environmental Cell scenario $200.7 million. For the Simulation scenario the recalibration costs are divided equally between A/C and USO6. For the FEC scenario A/C recalibration costs are $127.0 million and the USO6 costs are $73.7 million. Amortizing these costs over the assumed 5 year engine family life at 7 percent interest gives an estimated annual recalibration cost of $29.4 million for the Simulation and $48.9 million for the FEC scenarios ($31.0 million for A/C and $17.9 million for USO6). Dividing by the assumed 15 million vehicles sold results in an estimated $1.96 per vehicle for the Simulation and $3.26 per vehicle for the Full Environmental Cell ($2.06 for A/C and $1.20 for USO6).

4.2. Redesign Costs

As outlined in the Technical Support Document contained in the docket for this rulemaking and the hardware costs section of this RIA, the Agency has assumed that some engine families will require redesign for hardware changes to comply with the proposed rule.

Due to the nature of the expected Aggressive Driving and Air Conditioning redesign efforts (closed loop control EGR and increased catalyst loading), they entail redesigning the exhaust configuration of the engine family. Based on certification data, the Agency estimates there is an average of 1 exhaust configuration per engine family. Based on the air conditioning standards used in the SFTP the EPA has concluded that 34% of vehicles will need hardware changes (closed-loop EGR) to comply with the air conditioning design targets. The EPA also estimated that 10% of vehicles would require increased catalyst loading in response to the SFTP. 10% of 66% (the percentage of cars not being redesigned for closed loop EGR) equates to 6.6% of the cars needing redesign for catalyst loading. Assuming that each exhaust configuration redesign effort requires 4 person-months at $120,000 per person-year, and using 37.3 percent (34% plus 3.3% which is half of the redesign needed for catalyst loading) of the 340 federally certified engine families for A/C and 3.3 percent of the 340 for US06, the estimated redesign cost is $5.5 million ($5.1 million for A/C and $.4 million for US06).[22] Amortizing this cost over the 5 year engine family life at 7 percent interest results in an estimated annual redesign cost of $1.3 million ($1.2 million for A/C and $.1 million for US06). Dividing these costs by the assumed 15 million vehicles sold results in an estimated $0.09 per vehicle ($0.08 for A/C and $0.01 for US06). Because hardware changes are the same under both the Simulation and FEC scenarios the redesign costs are also equal.

4.3. Mechanical Integrity Testing on Redesigned Engine Families

Associated with each of the redesigns outlined above will be mechanical integrity testing. This involves mileage accumulation

[22]These percentages were derived from the market penetrations used in the hardware costs section, for further discussion see the hardware section of this document and in the Response to Comments.

time and effort to verify the integrity of the new designs. Using the appropriate assumptions outlined above for percentage of engine families redesigned (37.3% A/C and 3.3% for US06), one exhaust configurations per family, and 340 engine families, and assuming a rate of 30 mph over an average of 50,000 miles at $60 per person-hour, the estimated cost associated with mechanical integrity testing is $13.8 million ($12.7 million for A/C and $1.1 million for US06).

Amortizing the total cost over the 5 year engine family life at 7 percent interest gives an estimated annual cost of $3.4 million dollars for mechanical integrity testing ($3.1 million for A/C and $.3 million for US06). Dividing this cost by the assumed 15 million vehicle sales gives an estimated $.22 per vehicle associated with mechanical integrity testing ($.21 for A/C and $.01 for US06). Because Mechanical Integrity Testing costs are based on Redesign they are the same for the Simulation and FEC scenarios.

4.4. Certification Durability Demonstration

Each of the redesigned engine families will, presumably, require a new deterioration factor. This requires a durability demonstration vehicle (DDV) operated over 100,000 miles, with emission tests conducted every 10,000 miles, and appropriate reporting of results. To remain conservative, it is assumed that none of the engine families redesigned in response to the proposed action would have required a new deterioration factor for independent reasons and, therefore, costs are incurred for each redesigned engine family.

Again, assuming a rate of 30 mph over 100,000 miles at $60 per person-hour, the estimated cost for mileage accumulation on durability data vehicles for both the Simulation and FEC scenarios is $27.6 million, $25.4 million for A/C and $2.2 million for US06.

Assuming 30 emission tests per DDV (1 per 10,000 miles plus 2 voids) at $300 per emission test for the Simulation, $720 for the A/C part of the FEC and $120 for the US06 part of the FEC[23] (as proposed, durability demonstration will be done against the current FTP: $720-$600), the estimated testing cost for the Simulation is $1.2 million, $1.1 million for A/C and $.1 million for US06. The estimated testing cost for the FEC scenario is $2.74 million, $2.7 million for A/C and $.04 million for US06. The Agency estimates the reporting burden associated with DDVs at 60 hours per DDV.[24] Assuming $60 per person-hour, the estimated reporting burden associated with these DDVs is $.54 million for both the Simulation and FEC scenarios, $.50 million for A/C and $.04 for US06.

Adding these costs results in an estimated cost for durability demonstration of $29.4 million for the Simulation

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[23]Cost per test estimates are derived from AAMA/AIAM comments on the cost per shift and EPA estimates of tests per shift. For further discussion see Response to Comments section on testing costs.

An Information Collection Request document has been prepared by EPA (ICR No. 2060-????) and a copy may be obtained from Sandy Farmer, Information Policy Branch; EPA; 401 M St., S.W. (Mail Code 2136); Washington, DC 20460 or by calling (202) 260-2740.

scenario ($27.0 million for A/C and $2.4 million for USO6) and $30.9 million for the FEC scenario ($28.6 million for A/C and $2.3 million for USO6). Amortizing these costs over 5 years at 7 percent interest gives $7.2 million per year associated with the Simulation scenario ($6.6 million for A/C and $.6 million for USO6) and $7.5 million per year for the FEC scenario ($7.0 million for A/C and $.5 million for USO6). Dividing these by the estimated sales of 15 million vehicles gives an estimated per vehicle cost of $.48 associated with the Simulation scenario ($.44 for A/C and $.04 for USO6) and $.50 for the FEC scenario ($.46 for A/C and $.04 for USO6).

4.5. Annual Certification Costs

Annual certification costs are expected to increase due to the increased testing required and resultant increased emission testing costs. Testing costs for the different scenarios are greater than the original FTP testing costs, using AAMA/AIAM comments on costs per shift and EPA estimates of tests per shift the Agency has calculated the cost per test for the different cycles and scenarios. Based on these calculations the certification emission test costs for the Simulation scenario will increase by $240 ($1440-$1200).[25] The emission test costs for the FEC scenario for USO6/FTP will stay the same ($1,200 for USO6/FTP and $1,200 for FTP) but for A/C will increase by $720. According to the estimates given by AAMA/AIAM for the number of certification tests performed each year, there are 9,714 emission

[25]For further descriptions of the testing cost calculations see the Recalibration/Certification section of the Response to Comments.

tests performed by the manufacturers per model year. Using this test number and the cost per test given above the testing costs for the two scenarios were calculated. For the Simulation scenario the certification testing cost increase is $2.3 million per year. For the FEC scenario the testing cost increase is $0.0 for US06 and $6.9 million for A/C.

Associated with the increased testing burden will be an increased reporting burden. Assuming an increased reporting burden of 3 person-weeks per engine family at $120,000 per person-year, the increased reporting burden for the Simulation scenario is estimated at $2.4 million annually. For the FEC scenario the increased reporting burden is also $2.4 million annually for both A/C and US06.

Adding these costs results in an estimated increased certification cost of $4.7 million annually for the Simulation scenario and $11.7 million annually for the FEC scenario ($9.3 million for A/C and $2.4 million for US06). Dividing these costs by the assumed 15 million vehicle sales results in an estimated increase of $0.31 per vehicle associated with increased certification demonstration for the Simulation scenario and $0.78 for the FEC scenario ($0.62 for A/C and $0.16 for US06).

4.6. Test Facility Costs

The proposed test procedure requirements for the Simulation scenario are expected to result in three types of test facility costs: those for upgrades from existing 2-roll dynamometers to

48" single-roll electric dynamometers; those for construction of completely new exhaust emission test facilities to handle the increased testing demands; and those for construction of full environmental cells for A/C correlation.

The proposed test procedure requirements for the Full Environmental Cell scenario are also expected to result in three types of test facility costs: those for upgrades from existing 2-roll dynamometers to 48" single-roll electric dynamometers (USO6/FTP); those for construction of completely new exhaust emission test facilities to handle the increased testing demands (USO6/FTP); and those for construction of full environmental test cells for A/C related testing.

Based on information submitted by AAMA/AIAM the EPA has used their estimates upgrading and building the three types of facility changes. These costs include: a dynamometer upgrade to a 48" single-roll dynamometer at a cost $1.3 million per dynamometer; an entirely new emission test cell, including a 48" single-roll electric dynamometer at a cost $4 million per test cell and; the cost of a full environmental cell for A/C testing at $8 million.

The EPA, based on information from the manufacturers, estimates the testing burden at 152,193 for development tests and 9,714 for certification tests. The EPA also assumes (from AAMA/AIAM submittals) that the manufacturers perform tests 246 days per year with two shifts for certification testing and three shifts for development testing per day, and uses the following estimates of tests performed per shift (based on EPA calculations, for a more detailed description see the Facility Costs section of the Response to Comments):

Table 4.1
EPA Test per Shift Estimates

Procedure	Development Tests	Certification Tests
FTP	6	3
FTP/US06	5	3
FTP/US06/AC Simulation	4	2.5
A/C in a Full Environmental Cell	6	6

Based on the estimates and assumptions listed above the EPA has calculated the facility costs for the SFTP. The Simulation scenario imposes a need for approximately 26 new exhaust emission test facilities to be built at $4 million per cell for a cost of $116 million; 60 existing exhaust emission cells to be upgraded at $1.3 million per cell for a cost of $78 million; and 30 new full environmental cells to be built at $8 million per cell for a cost of $240 million. The total one time facility cost for the Simulation scenario is $422 million. Amortizing this cost over an assumed 10 year test facility life at 7% interest results in an estimated annual cost of $60.1 million ($25.9 million for USO6 and $34.2 million for A/C). Dividing these costs by the assumed 15 million vehicle sales results in an estimated increase of $4.01 per vehicle for the Simulation scenario ($2.28 for A/C and $1.73 for USO6).

The Full Environmental Cell scenario imposes a need for approximately 9 new exhaust emission test facilities to be built at $4 million per cell for a cost of $36 million; 60 existing exhaust emission cells to be upgraded at $1.3 million per cell for a cost of $78 million; and 55 new full environmental cells to be built at $8 million per cell for a cost of $440 million. The total one time facility cost for the FEC scenario is $554 million. Amortizing this cost over an assumed 10 year test facility life at 7% interest results in an estimated annual cost of $78.9 million ($16.2 million for USO6 and $62.7 million for A/C). Dividing these costs by the assumed 15 million vehicle sales results in an estimated increase of $5.26 per vehicle for the Full Environmental Cell scenario ($4.18 for A/C and $1.08 for USO6).

4.7. Vehicle Hardware Costs

Vehicle hardware costs are those costs for emission control hardware necessary to comply with the proposed regulations. Due to their nature, vehicle hardware costs are variable costs, ie., they vary with vehicle sales volumes. This analysis assumes a sales volume of 15 million vehicles outside the State of California.

The hardware cost estimates are directly correlated to the engine family redesign costs already discussed. Each of these engine family redesigns has associated with it some hardware cost. For this analysis, the percentage of engine families redesigned is assumed to correspond directly to the percentage of vehicles sold. While this effectively, and inaccurately, assumes that each engine family has equal sales volumes, the nature of the expected redesign efforts does not shed light on the number of vehicles affected (ie., if the expected redesigns included all 4 cylinder engines, the sales volume could be easily estimated from the number of 4 cylinder vehicles sold; however the redesigns are not expected on any separable aspect of the vehicle fleet).

The EPA, based on the cycles and associated standards it has set for A/C and USO6, estimates that the only hardware components needed, for the SFTP, would be Closed Loop Control EGR (for A/C) and Catalyst Loading (for A/C and USO6).[26] The EPA has incorporated those component costs into the hardware cost calculations using the market penetration estimates of EEA (EPA contractor) for Closed Loop Control and EPA estimates for Catalyst Loading:[27]

Table 4.2
Estimates of Hardware Cost and Penetration

Component	Component Cost	Market Penetration
Closed Loop Control EGR	$9	34%
Catalyst Loading	$13	10%

[26]For a more in depth discussion on hardware components see the Hardware section of the Response to Comments.

[27]For discussion on EPA and EEA hardware cost and penetration estimates see the Hardware section of the Response to Comments.

The EPA assumes that Closed Loop Control EGR is necessary for A/C and Catalyst Loading is necessary for A/C and US06 reductions in emissions, the costs and market penetrations for these control devices have been allocated to US06 and A/C accordingly.

The EPA has also applied a Retail Price Equivalency (RPE) to the hardware costs associated with the SFTP. Using guidelines laid out in the Jack Faucett report (10/85 Contract No. 68-03-3244), done for the EPA, on RPE for motor vehicle emission control equipment, the EPA for this rulemaking has multiplied the hardware costs by 1.29 to get the RPE (see the Jack Faucett report for more detailed information on RPE calculations).

Using the hardware cost and penetration assumptions and the RPE methodology, the EPA calculates a total hardware cost increase of $84.3 million ($71.8 million for A/C and $12.5 million for US06). Dividing these costs by the assumed 15 million vehicle sales results in an estimated increase in hardware costs of $5.62 ($4.79 for A/C and $0.84 for US06).

In addition to the per vehicle piece cost of the hardware, there are also one-time costs associated with retooling. Based on information in EEA's hardware cost report, written for the SFTP, the EPA has calculated the tooling costs associated with the hardware components and penetrations listed above. The cost of tooling associated with the hardware changes is $34.5 million ($26.7 million for A/C and $7.8 million for US06 hardware changes), when these costs are amortized over 5 years at 7% they result in total annual tooling costs of $8.4 million ($6.5 million for A/C and $1.9 million for US06).

Using the above hardware cost estimates, associated tooling costs, and RPE methodology the EPA calculates the estimated annual hardware cost of $92.7 million. Dividing this cost by the assumed 15 million vehicle sales results in an estimated increase of $6.18 per vehicle for both the Simulation and FEC scenarios.

4.8. Summary of Estimated Costs

Adding the above estimated costs results in an estimated annual cost of $198.9 million associated with the Simulation scenario, or an increase of $13.26 per vehicle. Under the Full Environmental Cell scenario, the estimated annual cost would be $244.5 million, and $16.30 per vehicle. The EPA does not anticipate that these cost per year totals will have any material effect on the national economy. Table 4.3 summarizes the estimated costs associated with the Simulation scenario and table 4.4 summarizes the costs associated with the Full Environmental Cell scenario. The per vehicle cost difference between the two scenarios is $3.04.

Table 4.3
Regulatory Cost Estimates
Simulation Scenario

	Simulation Annual Cost ($ million)	Simulation Cost/ Vehicle ($)
Common Costs		

Recalibration	29.4	1.96
Test Facilities	25.9	1.73
Certification	4.7	0.31
Common Cost Subtotal	60.0	4.00
US06 Costs		
Hardware	14.5	0.96
Redesign	0.1	0.01
Mechanical	0.3	0.02
DDV Testing and	0.6	0.04
Common Cost Subtotal/3	30.0	2.00
US06 Subtotal	45.5	3.03
A/C Costs		
Hardware	78.3	5.22
Redesign	1.2	0.08
Mechanical	3.1	0.21
DDV Testing and	6.6	0.44
A/C Test Facilities	34.2	2.28
Common Cost Subtotal/3	30.0	2.00
A/C Subtotal	153.4	10.23
Totals	198.9	13.26

Table 4.4
Regulatory Cost Estimates
Full Environmental Cell Scenario

	Simulation Annual Cost ($ million)	Simulation Cost/Vehicle ($)
US06 Costs		
Recalibration	18.0	1.20
Certification	2.4	0.16

Test Facilities	16.2	1.08
Hardware	14.4	0.96
Redesign	0.1	0.01
Mechanical	0.3	0.02
DDV Testing and	0.6	0.04
US06 Subtotal	52.0	3.47
A/C Costs		
Recalibration	31.0	2.06
Certification	9.3	0.62
Test Facilities	62.6	4.18
Hardware	78.3	5.22
Redesign	1.2	0.08
Mechanical	3.1	0.21
DDV Testing and	7.0	0.46
A/C Subtotal	192.5	12.83
Totals	244.5	16.30

It should be noted that these costs do not include any savings from the flexibilities allowed by the composite NMHC+NOx standard, as discussed above. In addition, potential fuel economy benefits to the consumer from control of commanded enrichment have also not been incorporated. The NPRM estimated the lifetime fuel economy savings to be $16.56, based upon an estimated 0.51% reduction in fuel consumption from control of commanded enrichment, miles driven and survival rates from the MOBILE model, a 7% discount factor, and a gasoline cost of $0.80 per gallon, excluding state and federal taxes. No fuel consumption benefit was claimed in the NPRM because the Agency assumed this benefit would be roughly negated by the value consumers would place on the small performance loss associated with elimination of commanded enrichment. However, in the Final Rule, the performance loss has been largely eliminated by raising the CO standard (see discussion in RTC on US06 CO standard setting) to allow commanded enrichment most of the time at WOT. Although the Final Rule would still control part-throttle commanded enrichment, this has no impact on the performance of the vehicle. As the Final Rule is estimated to still control about 80% of the CO benefit from commanded enrichment, it would be reasonable to conclude that the consumer would save about $13.45 ($16.56 times 80%) in fuel over the vehicle lifetime. As this cost reduction is no longer offset by a loss in vehicle performance, the Agency is being extremely conservative by not incorporating the potential fuel cost savings into the overall cost estimates.

As stated above the costs associated with the Revised FTP impact the original equipment manufacturers, there are no expenditure requirements of State, local and tribal governments as a result of this rule.

5. Cost Effectiveness

The cost effectiveness estimate represents the expected cost per ton of pollutant reduced. The costs developed in Section 5 are not necessarily equally spread among the three pollutant emissions (NMHC, CO, and NOx), nor are they equally spread among the two control areas considered in this analysis (US06 and A/C).

Tables 4.1 and 4.2 show the cost allocation to each of the control areas and pollutants for both the Simulation and FEC scenarios. For the Simulation scenario those costs designated "Common Costs" in this analysis, which refers to costs for engine control recalibration, exhaust emission test facilities, and certification are allocated equally to each control area and each pollutant emission. For both the Simulation and FEC scenarios those costs associated with the US06 cycle have been allocated equally to the three pollutant emissions. Since the requirements associated with A/C are targeted for NOx control, all costs associated with A/C have been allocated to NOx, for both the Simulation and FEC scenarios.

Table 5.1 contains the per vehicle cost allocation to each pollutant within each control area for the Simulation scenario. Table 5.2 contains the per vehicle cost allocation to each pollutant within each control area for the Full Environmental Cell scenario.

Table 5.1
Cost Allocation
Simulation Scenario
($/vehicle)

	NMHC	CO	NOx	Total
US06 Costs	1.01	1.01	1.01	3.03
A/C Costs	0.00	0.00	10.23	10.23
Total	1.01	1.01	11.24	13.26

Table 5.2
Cost Allocation
Full Environmental Cell Scenario
($/vehicle)

	NMHC	CO	NOx	Total
US06 Costs	1.16	1.16	1.16	3.46
A/C Costs	0.00	0.00	12.84	12.84
Total	1.16	1.16	14.40	16.30

Dividing the costs shown in Tables 5.1 and 5.2 by the discounted lifetime emission reductions shown in Table 3.2, gives the cost effectiveness estimates shown in Table 5.3.

Table 5.3
Cost Effectiveness Estimates
National Analysis
($/ton)

Control Area	NMHC	CO	NOx
US06			
Simulation	457	7.3	150
FEC	522	8.3	172
A/C			
Simulation	NA	NA	2050
FEC	NA	NA	2574

Total			
Simulation	457	7.3	959
FEC	522	8.3	1194

Using the same costs and methodology as above the EPA has also performed a regionalized analysis of the SFTP rule in which the emissions benefits from the SFTP are adjusted for the fraction of emissions which occur in the regions that are expected to have an impact on ozone levels in ozone nonattainment areas (excluding California which is not covered by this rule). Air quality modeling indicates that these regions include all of the states that border on the Mississippi River, all of the states east of the Mississippi River, Texas, and any remaining ozone nonattainment areas west of the Mississippi River not already included. Approximately 86 percent of the nationwide (excluding California) NOx and VOC emissions from LDV and LDT occur in these regions (see table 5.4). Therefore, for the regional ozone control strategy cost-effectiveness calculations, the per-vehicle NOx and NMHC emission reductions were multiplied by a factor of .86 (i.e., reduced by 14 percent) to account for the impact that the proposed new engine standards will have on ozone levels in ozone nonattainment areas. It should be noted that the regional methodology excludes all benefits associated with emissions reductions in attainment areas, including prevention of deterioration and reduced transport of pollutants.

Table 5.4
Distribution of LDV LDT NOx Emissions Affecting Nonattainment Areas (Excluding California)

Area	Percent of Non-California LDV and LDT Emissions in Area
States east of the Mississippi River	65.9
States bordering Mississippi to the west	9.3
Texas	7.5
Western NAA in other states	2.9
Total	85.7

The regionalized cost-effectiveness numbers are as follows:

Table 5.5
Cost Effectiveness Estimates
Regional Analysis
($/ton)

Control Area	NMHC	CO	NOx
US06			
Simulation	531	8.5	175
FEC	607	9.7	200
A/C			
Simulation	NA	NA	2384
FEC	NA	NA	2992

Total			
Simulation	531	8.5	1115
FEC	607	9.7	1388

In summary, it should be noted that the emission benefits in all of the cost effectiveness calculations are likely to be understated, as discussed above, because they do not consider the impact of in-use vehicles with malfunctions and higher deterioration on the off-cycle emission inventory. In addition, the costs are likely to be greatly overstated, as they do not include any savings from the flexibilities allowed by the composite NMHC+NOx standard or from fuel consumption reductions, as discussed above. Considering both the potential understatement of the emission benefits and the overstatement of the costs, the cost-effectiveness estimates presented in Tables 5.3 and 5.5 are extremely conservative.

The Agency considered several regulatory options in the development of the rule.[28] The option selected in the final rule is the most cost-effective alternative currently available for achieving the objectives of sections 202, 206, 208, and 301.

[28]For discussion of alternatives see the Response to Comments for this rule.

6. Regulatory Flexibility Analysis/Impact on Small Entities

The EPA prepares a regulatory flexibility analysis (RFA) when it publishes a rulemaking that will have a significant economic impact on a substantial number of small entities. The EPA makes this determination based on the number of small entities which are directly regulated by the rule. See Mid-Tex Electric Cooperative, Inc. V. FERC, 773 F.2d 327 (D.C. Cir. 1985) (Agency need only consider the rule's impact on regulated entities and not indirect impact on small entities not regulated). The Supplemental Federal Testing Procedures will directly regulate auto manufacturers. Since these auto manufacturers generally do not qualify as small businesses within the meaning of the Regulatory Flexibility Act, EPA does not believe a RFA is needed for either the proposed or final rules. Accordingly, the EPA finds that this rule will not have a significant economic impact on a substantial number of small entities.

Appendix A: Vehicle Lifetime Emission Reduction Calculations

Appendix B: Fleet Wide Annual Emission Reductions

Appendix C: Reduction in Light-Duty Fleet Emission Factors

Appendix D: Cost Calculations