

State of California
AIR RESOURCES BOARD

**STAFF REPORT: INITIAL STATEMENT OF REASONS FOR
RULEMAKING**

Cool Car Standards and Test Procedures

Date of Release: May 8, 2009

Scheduled for Consideration: June 25-26, 2009

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**Staff Report: Initial Statement of Reasons
for Proposed Rulemaking**

**PUBLIC HEARING TO CONSIDER THE ADOPTION OF COOL CAR
STANDARDS AND TEST PROCEDURES**

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LIST OF ACRONYMS

ARB	Air Resources Board
CO	Carbon Monoxide
CO ₂	Carbon Dioxide
CO ₂ e	Carbon Dioxide equivalent
FMVSS	Federal Motor Vehicle Safety Standard
GPS	Global Positioning System
GVW	Gross Vehicle Weight
GWP	Global Warming Potential
MMT	Million Metric Tons
LBNL	Lawrence Berkeley National Laboratory
NO _x	Oxides of Nitrogen
NREL	National Renewable Energy Laboratory
PET	PolyEthylene Terephthalate
PVB	PolyVinyl Butyral
ROG	Reactive Organic Gases
U.S.	United States

EXECUTIVE SUMMARY

The California Global Warming Solutions Act (Assembly Bill 32) has the goal of reducing California's greenhouse gas emissions. This proposal would contribute to that goal by reducing the load on mobile air conditioners and the percent of time that mobile air conditioners are in use. The use of mobile air conditioners increases greenhouse gas emissions as well as other criteria pollutants.

When a vehicle is parked in the sun, the sun's energy travels into the vehicle through the sheet metal and windows, warming it to levels high above ambient temperatures. If some of this energy were to be blocked or reflected back into the environment, the interior temperature would remain cooler. Further, the air conditioner would not have to work as hard, and would be less likely to be used as often or for as long.

This proposal takes advantage of the fact that solar radiation is composed of both visible light, which determines color, and invisible light. Slightly over half of the energy from the sun is invisible. Solar management glazing (or glass) can block the sun's invisible energy, while maintaining good visibility through the windows. The staff of the Air Resources Board (ARB or Board) proposes to adopt solar management standards for automotive window glazing.

Proposed Requirements

Staff proposes that newly manufactured light- and medium-duty vehicles less than or equal to 10,000 pounds GVW use solar management window glazing that limits the transmission of solar energy into the vehicle. These requirements would reduce the interior temperature of the vehicle. The reduced vehicle temperature would make the driver less likely to turn on the air conditioner and allow manufacturers an opportunity to reduce the size of a vehicle's air conditioning unit. Together, this would reduce the vehicle's greenhouse gas emissions, primarily by reducing fuel use. These proposed requirements would begin with the 2012 model year (first tier). Beginning with the 2014 model year (second tier), more stringent requirements would apply. Replacement windows for affected vehicles would also use solar management glazing. Labeling for the windows (both original and replacement) would also be required.

Solar management automobile glazing is available. Most glazing suppliers will be able to meet the 2012 requirements with existing products, and little new development will be needed. Models sold in Europe such as the Mercedes Benz S-Class and the Ford Focus already offer solar control windshields as part of a comfort option. For the 2014 requirement, one supplier already has a product that will comply with the proposed requirements, and a second has publicly stated that they will have complying product soon. Most suppliers will need to develop and validate a product with greater performance than those currently commercially available for the second tier requirement. Solar management glazing is installed in an identical manner as current glazing.

This proposal would not disproportionately affect environmental justice communities. An earlier version of staff's proposal that aimed to achieve reduced soak temperatures through the use of solar reflective paint and coating systems was supported at the June 2007 Board hearing by the Environmental Justice Advisory Committee.

Environmental and Economic Impacts

This proposal will result in a reduction of greenhouse gas emissions, primarily carbon dioxide (CO₂), of 0.7 million metric tons per year by 2020 and approximately 1.2 million metric tons per year by 2040. Based on anticipated increases in cost for solar management glazing of \$111 per vehicle, and projected savings resulting from reduced fuel use of \$16 per vehicle per year, the proposed measure is expected to have a net savings of \$348M in 2040. Criteria pollutants such as oxides of nitrogen and reactive organic gases, will also be reduced.

In addition, there exists a potential benefit that ranges from 2.0 to 8.3 million metric tons nationwide if automobile manufacturers elect to use solar management glazing on all their vehicles sold in the United States.

Regulatory Authority

The proposed regulations, as described herein, are consistent with the authority of ARB to control emissions from mobile sources.

Staff Recommendations

ARB staff recommends that the Board adopt the new regulations as set forth in the proposed Regulation Order as Appendix A and as described in this Initial Statement of Reasons.

I. INTRODUCTION

In 2006, California adopted the California Global Warming Solutions Act, Assembly Bill 32. This law created a comprehensive, long term plan for California to reduce greenhouse gas emissions to 1990 levels by 2020. The energy and transportation sectors are the major contributors to greenhouse gases in California. The Air Resources Board (ARB or Board) has previously adopted regulations to address tailpipe greenhouse gas emissions from light-duty vehicles. Staff's proposal, the focus of this staff report, further addresses greenhouse gas emissions from the light- and medium-duty sectors.

Impact of Vehicular Air Conditioning

The National Renewable Energy Laboratory¹ (NREL) has determined that the United States (U.S.) uses about seven billion gallons of fuel per year for air conditioning in light-duty vehicles. This is equal to about 5.5 percent of the total national light-duty fuel use. In California, NREL projects that 730 million gallons of fuel are used annually for cooling and dehumidification (Rugh et al., 2004). Running a vehicle's air conditioner increases emissions of criteria and non-criteria pollutants, including carbon monoxide and carbon dioxide (CO₂), both considered to be greenhouse gases. Use of the air conditioner can increase fuel consumption on conventional vehicles by more than 20 percent. However, fuel consumption can vary considerably depending on how technically advanced the vehicle's engine is, and its size. In general, for smaller and/or more advanced engines air conditioning usage has more of an impact on fuel consumption.

There are several ways to reduce mobile air conditioner fuel use -- one can make the air conditioner smaller, make it more efficient, or reduce the demand for (use of) air conditioning. Cooling a vehicle down requires a cooling load two to four times greater than that required to maintain a comfortable temperature (steady state load) (Farrington et al., 2000). The focus of staff's proposal is to reduce the initial cooling load for air conditioning, and the demand for air conditioning, by reducing the vehicle's interior temperature. The proposed measure is an early action item identified in ARB's Greenhouse Gas Scoping Plan, adopted in December 2008.

Reducing Air Conditioner Load and Demand

The interior temperature of a parked vehicle is referred to as the "soak temperature". A black sedan parked in the sun can reach interior temperatures above 180°F (Farrington et al., 1998). The high temperatures encourage those entering the vehicle, regardless of ambient temperature, to turn on the air conditioner. Once on, the tendency is to continue to use the air conditioner for the entire trip. If the soak temperature can be reduced, some trips that would have used the air conditioner may be completed without its use, thereby reducing fuel use, greenhouse gas emissions,

¹ The U.S. Department of Energy's National Renewable Energy Laboratory is the nation's primary laboratory for renewable energy and energy efficiency research and development. NREL's mission and strategy are focused on advancing our nation's energy goals. For more information about this national laboratory, visit <http://www.nrel.gov>

and the emissions of other criteria pollutants. Reducing heat buildup and/or allowing the hot air in the vehicle to “vent” out to the atmosphere will enable the use of a smaller air conditioner, resulting in initial cost savings for the smaller unit, less refrigerant use to charge and recharge the unit, greater flexibility in where to physically locate the unit, and more efficient use during normal conditions.

There are a variety of methods to reduce the soak temperature of a vehicle, including paint choices, window glazing approaches, and ventilation.² When first envisioned, this regulatory proposal focused on the use of solar reflective paint. As more information became available on the status of technologies that could be used to reduce solar load, the decision was made to expand the scope to include window glazing approaches. With a brief discussion on solar reflective paint, below, the focus of this proposal is only on window glazing technology.

II. SOLAR REFLECTIVE PAINT

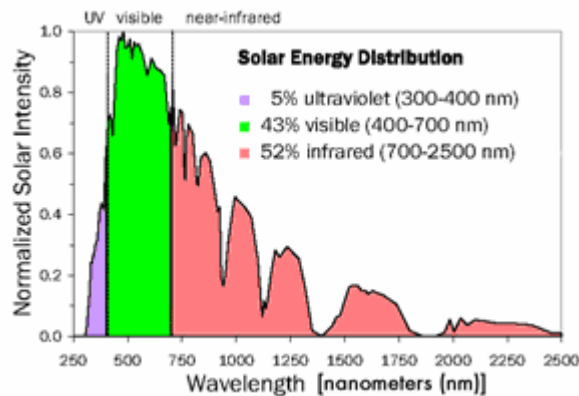
A white vehicle parked in the sun is cooler to the touch than a black one. This is because white is a “reflective” color, while black absorbs light energy. Some of the additional energy absorbed by the black vehicle is transferred into the vehicle, making the interior of the black vehicle warmer than the interior of the white one. NREL tested two sport utility vehicles, one black and one white. The black vehicle had a reflectivity of about 5 percent, while the white vehicle had a reflectivity of around 50 percent. The exterior skin temperature of the white vehicle was substantially cooler than that of the black vehicle, and the interior air temperature at typical head levels (breath air temperature) was 4.6 degrees C lower (Hoke & Greiner, 2005).

Solar reflective paint formulations take advantage of the fact that the light we see does not account for all of the solar radiation. In fact, as shown in Figure 1, less than half of the solar radiation is in the form of visible light – the balance is infrared and ultraviolet light. The colors we see are those reflected in the visible light range. A white color is seen when most of the visible light is reflected instead of being absorbed, while a black color is seen when the visible light is absorbed and little is reflected. The ideal infrared-reflecting black paint would absorb all ultraviolet light and visible light to provide a deep black color and reflect all infrared light energy. Theoretically, this paint could have a reflectance of over 50 percent (Figure 1). However, there are technical challenges associated with producing such an “ideal” black paint.

Currently, most dark colored paints use carbon black as a pigment. Carbon black is very opaque, and has excellent coverage properties. But carbon black is extremely absorbing of infrared as well as visible light energy. To improve reflectance of dark colored paints, carbon black must be removed or substantially reduced. Staff investigated pigment choices that are currently available or under development to replace carbon black. Unfortunately, while many solar reflective “blackish” pigments

² For a discussion of some of these options, staff refers the Rugh & Farrington, 2008.

Figure 1. The Solar Spectrum.



Source: Lawrence Berkeley National Laboratories, Berkeley, California

are available, none offer the excellent hiding performance or true jet black color that is obtained through the use of carbon black. In addition, these pigments tend to be much more expensive than carbon black. Therefore, although staff believes that solar reflective paint can and should be developed for automotive use, staff was unable to clearly identify a technology path at this time that would lead to improved solar performance with acceptable color choices, costs, and ease of application. Staff believes that this approach should be further considered for a future rulemaking but that it is premature to include solar reflective paint herein.

III. SOLAR CONTROL GLAZING

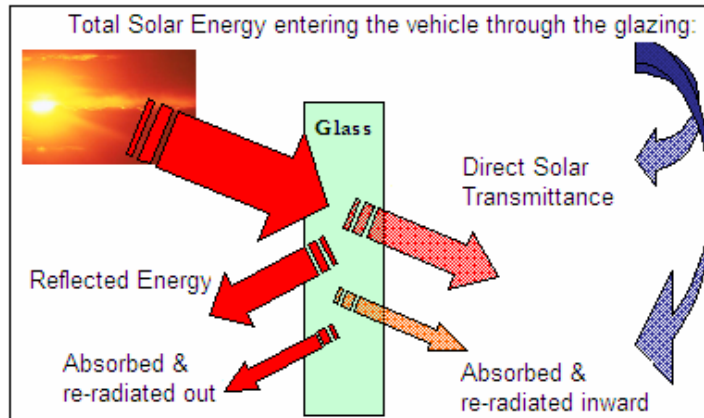
A. Background

Significantly more energy enters the vehicle's interior through the windows than conductively through the paint. When a vehicle is parked, up to 75 percent of the thermal energy entering the passenger compartment is from solar energy transmitted through and/or absorbed and re-radiated by window glazing. Given the trend towards increased use of glass in many vehicles, staff investigated the benefits of glazing provisions for the proposed regulation.

Solar energy enters the vehicle through the glazing via multiple pathways, as shown in Figure 2. First, light energy can pass directly through the glazing. This is referred to as directly transmitted energy. Second, light energy can be absorbed by the glazing. Ultimately, the absorbed energy is either released to the environment or released to the interior of the vehicle.³ Third, light energy can be reflected off the glazing. This rejected energy does not contribute to solar heat gain inside the vehicle. The glazing can be designed to perform differently for ultraviolet, visible, and infrared energy. With selective solar radiation control, the visible light can be transmitted while the ultraviolet is absorbed and the infrared is reflected.

³ The exact split depends on a variety of environmental and other conditions.

Figure 2. Solar Energy Pathways.



Depending on vehicle orientation and geometry, 40 to 60 percent of the energy that enters the vehicle through the glazing enters through the windshield. An additional 25 to 30 percent enters through the side windows (i.e., sidelites), and 10 to 35 percent enters through the rear window, or backlite. Up to 50 percent more energy can enter the cabin if a sunroof or moonroof (i.e., rooflite) is present (Lugara, 2006; Southwall Technologies, 2008).

Staff discussed current and anticipated glazing technology with glass and film suppliers including AGC Automotive (Asahi Glass), Bekaert Specialty Films (Bekaert), Exatec LLC, Guardian Industries Corporation (Guardian), 3M, Pilkington Automotive (Pilkington), Pittsburgh Glass Works (PGW, formerly part of PPG Industries), Saint Gobain Sekurit, Sekisui S-lec, Southwall Technologies (Southwall), and Zeledyne. To a great extent, staff's proposal reflects input received from these discussions, as described below.

B. Current Technology

Current automotive glazing may be tempered or laminated. Each type of glazing has advantages and drawbacks. Tempered glass is less expensive than laminated glass and is easier to produce. It can be drilled and mountings made directly through the glass. In addition, very thin tempered glass can be manufactured. The addition of materials to the molten glass enables automotive tempered glass to be produced that can moderately reduce solar heat gain inside the vehicle. Automotive windshields are required to use laminated glass, because this glass is more difficult to break, and tends to retain its shape and position even when broken. This is because laminates are made by sandwiching a thin layer of polyvinyl butyral (PVB) plastic between two sheets of flat glass. The plastic layer keeps the glass fragments together. The extra processing and the plastic layer mean that laminated glass is generally more expensive than tempered glass. In addition, laminated glass cannot be drilled, so windows must be held in a support frame. Nonetheless, this type of glass offers

improved acoustic performance as well as improved vehicular security, and so is used throughout some mid- and high-end vehicles as part of a “quiet ride” comfort package. Laminated glass has additional options to reduce solar heat gain because solar management films can be protected between the two layers of glass and solar control products can be applied directly to the interior glass surface(s). This allows a greater degree of solar control with laminated than with tempered glass.

While laminated glass use is required for windshields in the U.S., few of these windshields use optimized solar control. Most sidelites currently use tempered glass, generally without significant solar control. (Projections provided to staff indicate that about 40 percent of current front sidelites in the U.S. use good solar control, and perhaps a quarter of rearward sidelites and backlite(s) are so equipped.) Some manufacturers have all-around laminated glass in their more expensive models, primarily to reduce noise or as a security measure. There is a trend towards increased use of laminated glass (Pilkington, 2008; PGW, 2009); this regulation could accelerate the trend.

C. Solar Control Products

Solar control glazing or film is available from many manufacturers. Private meetings with glass industry representatives indicate that most suppliers currently offer solar reflective products in the 22 to 35 percent reflectivity range. Most of these products allow no more than 50 percent of the total solar energy into the vehicle, and will meet the proposed 2012 model year requirement for windshields. In Europe, approximately 20 percent of vehicles are equipped with solar reflective windshields. Glazing with a solar reflectivity of 45 percent has been developed by at least one manufacturer, and other manufacturers are actively working on this level of solar control. This level of control will comply with the proposed 2014 model year windshield requirement. Solar absorbing products are also widely available. These tend to reflect only a small percent of the solar energy (less than 10 percent), but keep half or more of the absorbed energy out of the vehicle. Most suppliers currently have solar absorbing products that allow no more than 60 percent of the total solar energy into the vehicle. This level of control will meet the proposed 2012 model year requirements for the side and rear glazing positions.

Advanced approaches to reduce the solar energy entering the passenger compartment through window glazing include making the windows opaque while parked through the use of electrochromic switchable glazing.⁴ The advanced approaches can be very effective, but are not yet sufficiently developed for widespread commercialization, or are currently prohibitively expensive for most automotive use.

⁴ This glazing is currently used in the panoramic roofline of some Ferrari models. In addition, electrochromic mirrors are offered on many vehicle models.

D. Solar Control Glazing Effectiveness

Numerous studies have been conducted in recent years demonstrating the effectiveness of solar control glazing. All-around solar reflective glazing can reduce interior soak temperatures by as much as 10 degrees C, depending on the product and test conditions; more typical results, included in Appendix C, are in the 7-9 degrees C range (see, for example, Rugh et al., 2007; Lugara, 2006; Farrington, 2000). All-around solar absorbing glazing also reduces interior soak temperatures when compared to standard green tint windows, although not quite as effectively as reflective glazing. Typically, interior soak temperatures with solar reflective glazing are around 2 degrees C cooler than seen with solar absorbing glazing. Because the reflective glazing tends to keep the windows cooler than does glazing that absorbs much of the solar energy, the reflective glazing more effectively minimizes “hot arm syndrome”.⁵

Thus, the better-performing solar reflective glazing should ideally be used throughout the vehicle.

However, requiring solar reflective glazing throughout the vehicle would typically necessitate the use of laminated glass rather than the tempered glass more commonly found in the sidelites and backlites of U.S. cars. A switch to laminated glass would involve an additional expense. Discussions with manufacturers indicate that if a typical piece of sidelite glass currently costs the manufacturer around \$7, a laminated replacement piece might cost slightly over \$20. This is a 3-fold increase in cost, before any solar control is added. This cost difference is relatively large for the benefit to be obtained in locations where laminated glass is not currently used. Therefore, staff’s proposal sets a “total solar transmission limit”⁶ for the different glazing locations rather than specify the use of solar reflective glazing.

IV. OTHER APPROACHES

Insulation: Insulation is used in many areas of the vehicle, though the focus has been more on noise reduction than temperature regulation. The benefit of headliner insulation depends on exterior surfaces and interior temperatures. If the interior is substantially warmer than the exterior, increasing the insulation in the headliner may actually make the car warmer. The decision to utilize additional insulation requires system-based considerations.

⁵ “Hot arm syndrome” refers to the increased thermal sensation on a vehicle occupant’s arm due to the solar energy that passes through the glass into the vehicle. This generally causes discomfort and can lead to air conditioner use even where the average interior temperature is not uncomfortably warm.

⁶ “Total solar transmission” or “Tts” is a measure of the amount of solar energy that passes through the glazing (including energy absorbed and subsequently re-radiated to the interior) compared to all the solar energy falling on the glazing. It is usually expressed as a percent. The total solar transmission limit is the maximum amount allowed for a particular model year in each glazing position under this proposed regulation.

Cool Materials: Upholstery that reflects instead of absorbs the short-wave radiation leaves it in the short-wave form, which can pass back out through the windows. Solar reflective materials on seats, dash (especially the steering wheel), and arm rests also can make the vehicle seem more comfortable even when at a higher temperature. Such materials are available.⁷ Thermoregulating materials are also being developed, such as phase change materials (see, for example, Pause, 2002) that absorb soaked heat and release it slowly during vehicle operation when the air conditioner system can easily accommodate it.

Ventilation: Parked-car ventilation can effectively remove accumulated heat. A small fan, powered by a photovoltaic cell, can exchange interior air with exterior air. Such ventilation systems are present on at least two European models (Friedrich, 2007). An even simpler approach, leaving the sidelites open 2 cm can reduce cabin air temperatures (Rugh & Farrinton, 2008).

Delivery Methods: Improving the delivery methods for conditioned air is another effective way to increase thermal comfort at little energy cost. The better the cool air is directed at the occupant(s), the less is needed to achieve comfort. When efficient delivery methods result in equivalent thermal comfort at higher cabin temperatures, the air conditioner load is reduced, and greenhouse gas emission reductions are achieved.

Due to insufficient data, staff's proposal would not require any of these approaches. However, staff believes that these should be considered and pursued by manufacturers, as should solar reflective paints. Indeed, these technologies could be part of future regulatory efforts to reduce mobile air conditioning use.

V. OTHER VEHICLE CLASSES

Many of these thermal load reductions and improved comfort technologies can be applied to larger medium- and heavy-duty vehicles. Despite ARB's existing idling-restriction rules for heavy-duty trucks, many truckers may leave their vehicle running to provide air conditioning during brief rest periods or when goods are being loaded and unloaded. Reducing the heat gain during these periods might enable the cabin to remain sufficiently cool so as to not require air conditioning. Again, due to insufficient data, staff's proposal does not apply to vehicles over 10,000 pounds GVW. But these vehicles could also benefit from the proposed requirements. Staff intends to further evaluate this issue.

VI. THE REGULATORY PROPOSAL

This measure would reduce the need for air conditioning during times of moderate ambient temperature and/or short soak periods, and would allow manufacturers to downsize the air conditioner for year-round emissions improvements.

⁷ See, for example, www.ips-innovations.com/automotive_applications.htm

A. The Regulatory Proposal

Staff recommends that the Board adopt a new Subarticle 9, sections 95600 to 95605, to title 17, California Code of Regulations, as set forth in Appendix A. All the provisions in the proposed regulation would apply to passenger vehicles less than or equal to 10,000 pounds GVW (“passenger vehicles”) produced for sale in California.

Staff is proposing that newly manufactured passenger vehicles use solar management glazing. Beginning with model-year 2012, windshields would be required to transmit no more than 50 percent of the total solar energy into the vehicle. This includes visible light, as well as ultraviolet and infrared (heat) energy, and would be accomplished using generally available technology. Rooflites that transmit no more than 30 percent of the total solar energy would also be required. The balance of vehicular glazing would be required to transmit no more than 60 percent of the total solar energy. Most glass manufacturers currently offer this level of solar control. A second tier requirement for the windshield, limiting total solar transmission to no more than 40 percent, would begin with model-year 2014. Two glazing manufacturers have publicly stated that they have or will have met or exceeded this level of control by 2014. Staff is further proposing options wherein manufacturers may trade improved performance in one glazing area for reduced performance in another.

The proposed regulation also requires that automotive glass replaced on vehicles that would be subject to these requirements also comply with transmission requirements.

Current automobile glazing has various supplier and safety information on it. The proposed regulation also requires that automotive glazing (new and replacement) must have symbols/icons or other identifiers so that glazing replacers, consumers, and enforcement personnel can readily identify complying product. Staff plans to provide examples of such identifiers to the Board at the hearing.

Staff also recommends that manufacturers consider the use of additional techniques to reduce air conditioner load such as active or passive parked-car ventilation; solar reflective paint and coating systems; active or passive climate-control seating; maximally efficient air conditioner components; increased use of recirculated air,⁸ where appropriate; and elimination of overcooling and subsequent reheating of air that may occur to achieve the desired temperature in vehicles with automatic temperature control systems.

B. Regulatory Alternatives

Various regulatory alternatives have been considered, summarized in Table 1, but were rejected by staff. As shown, each of the alternatives has an associated emissions benefit. Discussion of how these benefits are calculated is included in Appendix B.

⁸ Staff notes that when activating the air conditioner of a vehicle, the interior of which is hotter than ambient, it would be most efficient if the system automatically drew in the cooler air until equilibrium is reached.

Requiring solar management glazing at the 60% total solar transmission level throughout the vehicle would result in the equivalent of 0.85 MMT CO₂ reduced per year with full implementation. Setting an all-around 50% total solar transmission level would result in the reduction of 1.18 MMT CO₂ per year in 2040. The most benefit would be achieved if all-around solar management glazing with a maximum total

Table 1. Regulatory Alternatives

Alternative	Reductions
Tts of 60%, all-around	0.85 MMT CO ₂ per year
Tts of 50%, all-around	1.03 MMT CO ₂ per year
Tts of 40%, all-around	1.34 MMT CO ₂ per year
Performance Standard	1.18 MMT CO ₂ per year
Staff's Proposal	Reductions
Tts of 40% for windshield; specified requirement for other glazing	1.18 MMT CO ₂ per year

solar transmission of 40 percent were required. However, with current and anticipated technological approaches, such a level of control would also require all-around laminated glazing, at a substantially increased cost.

A performance standard alternative could set a target for air conditioner-associated greenhouse gas emissions, a soak temperature reduction target, a maximum solar load target, or some other metric that is ultimately associated with reduced air conditioner emissions. The reduction goal could be met by a combination of the use of solar reflective paint, solar management window glazing, passive or active ventilation, insulation modifications, seat ventilation, or other technological approaches to reduce interior soak temperatures, or by improvements to the delivery of cooled air. Although a general requirement to reduce the soak temperature by a given percentage or given number of degrees would provide flexibility, compliance would be more complex, as the geometry and specific design of each vehicle will affect the reductions obtained, and crafting the requirement in such a way would require extensive testing or modeling of vehicle body and interior packages. In addition, enforcement could be very difficult.

Staff's proposal, applying the most stringent requirement to the windshield and roofite only, and a lesser requirement to other glazing, will result in a benefit of 1.18 MMT CO₂ per year in 2040.

Having considered these alternatives, staff concludes that the proposed requirements most effectively and efficiently achieve the desired reductions in greenhouse gas emissions.

C. Regulatory Authority

The proposed regulations, as described herein, are consistent with the authority of the ARB to control emissions from mobile sources. Specific authority cited in the proposed regulatory language includes Health and Safety Code sections 38501, 38510, 38560, and 38562, 39600, and 39601.

D. Outreach Efforts

ARB strives to involve the widest number of affected persons in the development of its regulations. For this rule, staff conducted two public workshops and numerous additional focused meetings. Notices for the workshops, held on May 15, 2008, and March 12, 2009, were posted to ARB's website and emailed to subscribers of ARB's electronic list server. The workshops were held in El Monte, California, and conference lines were available for individuals who could not travel to the meeting location. Approximately 40 people attended each workshop; many additional people attended by teleconference. To generate additional public participation and to enhance the information flow between ARB and interested persons, staff made all documents, including workshop presentations, available via the website. In addition, the website serves as a portal to other websites with related information.

Staff also attended the National Glass Association's annual conference in Orlando, Florida and gave a presentation on the proposed regulation to the attendees on February 19, 2009. The primary purpose for staff's participation in the conference was to find out what impact the rule would have on the automobile replacement glass industry. Attendance at the conference served as an opportunity to interact with presidents/owners of automobile glass retail shops, adhesive suppliers, and executives from the top glazing suppliers in the world.

In addition to the workshops and conference noted above, staff participated in individual meetings in person or via telephone with glass and window film suppliers including Asahi Glass, Bekaert, Exatec, Guardian, 3M, Pilkington, PGW, Saint Gobain, Sekisui, Southwall, and Zeledyne, as well as Chinese glass suppliers (via email). Staff also met with many vehicle manufacturers individually and in group meetings organized by the Alliance of Automobile Manufacturers. At these meetings, current and future anticipated technology, research needs, regulatory alternatives, and other issues were discussed. Suggested alternatives were explored by staff, and were incorporated where appropriate. Numerous informal telephone and email communications also occurred with these and other interested parties including environmental organizations and research institutions.

E. Implementation Barriers

The primary implementation barrier for solar management glazing is one of increased cost. If consumers were to demand better climate control along with lower fuel use, automobile manufacturers would have a financial incentive to incorporate these technologies absent regulation. But most consumers do not know the technologies exist. Surveys indicate that most consumers, when informed of the benefits of these

technologies, show interest in purchasing them, and, in general, are willing to pay more than their current retail cost (see, for example, Harris Interactive, 2007).

Manufacturers have expressed some concern about the potential for solar reflective glazing to interfere with reception for sensors and devices such as cellular telephones and global positioning systems (GPS). However, deletion windows⁹ can be used to ensure good reception, and provisions for deletion windows are included in the proposed regulation. The issue has been successfully addressed in Europe, where many vehicles use solar reflective windshields, and some models currently offer solar reflective glazing in all window locations. Staff further believes that reception should not be a major issue since reflective glazing is not required in all glazing positions in the proposed regulation.

VII. ENVIRONMENTAL AND ECONOMIC IMPACTS

A. Benefits

Estimates of the emissions benefit for this proposed regulation are complicated by the credit system that was included in ARB's rulemaking for AB 1493,¹⁰ adopted in 2004. That regulation includes CO₂ credits for reducing indirect air conditioner emissions. Indirect emissions are the result of the load from the air conditioner on the engine; using the air conditioner increases the load, and the fuel consumption of the vehicle, compared to operation of the vehicle with the air conditioner off. There are a variety of methods that can be used to obtain credits for an improved air conditioner system, such as improved refrigerants, improved air circulation methods, and the use of externally controlled variable displacement compressors.

The credits in the AB 1493 rulemaking are based on the benefits obtained.¹¹ To estimate the benefits of this proposal, staff assumed that all manufacturers would choose to generate credits from the use of improved air conditioner systems. This assumption ensures that the benefit from switching to better air conditioners is not inappropriately double counted in the projected benefit from this regulation. Accordingly, the projected baseline inventory was adjusted downward for this assumption. The effect of staff's proposal was layered onto the adjusted baseline inventory. Details are included in Appendix B.

The calculated emission benefit is based on a likely reduction in soak temperature of around 7 degrees C, depending on vehicle type. Staff applied the reduced interior temperatures to the work demand for the air conditioner compressor, following the methodology presented in Appendix B. The lower compressor demand¹² will lead to

⁹ Deletion windows are areas on a vehicle's glazing specifically designed to facilitate transmission of electromagnetic signals into and out of the vehicle.

¹⁰ AB 1493 (Pavley) directs ARB to adopt regulations to achieve the maximum feasible and cost-effective reduction of greenhouse gas emissions from motor vehicles.

¹¹ Staff directs the reader to the Staff Report for the AB 1493 regulation (ARB, 2004), specifically the discussion surrounding Table 5.1-12 (page 75).

¹² Air conditioner systems for vehicles are typically sized to achieve cool-down of a black vehicle parked for four hours in the Phoenix summer sun to a comfortable temperature in a set amount of

reduced greenhouse gas emissions of 0.86 MMT per year in 2040. In addition to these benefits, the cooler interior temperature is anticipated to result in reduced use of the air conditioner during periods of mild temperatures and/or short soak. Using the methodology described in Appendix B, staff estimated that an additional 0.29 MMT CO₂ reduction would be achieved during these times. Another 0.03 MMT benefit is estimated for vehicles that have left California.

There are other non-quantified benefits. The ability of the manufacturers to utilize a less powerful air conditioner will have associated non-quantified benefits: A smaller unit would be charged with a smaller volume of refrigerant, so less refrigerant would be released throughout the vehicle’s life and in a leak situation, further reducing greenhouse gas emissions. A smaller unit would also be lighter and easier to physically locate within the engine compartment. In addition, a smaller unit would be less expensive.

In 2040 (near full implementation), staff estimates that the proposed requirements would result in a reduction of 1.18 MMT CO₂ per year. In 2020, approximately 0.68 MMT CO₂ would be reduced. In addition, emissions of other criteria pollutants such as oxides of nitrogen (NO_x), and reactive organic gases (ROG) would also be reduced. Based on the cost differential for solar management glazing, discussed in the next section, staff believes it probable that manufacturers will opt to utilize solar management glazing in the sidelites and backlites nationwide, and may even choose to use the high-performance windshields in all vehicles as well. If so, additional 2040 benefits of 1.96 to 8.30 MMT CO₂ per year are anticipated. Quantified emission benefits are summarized in Table 2, and their derivation explained in Appendix B. With full implementation, this measure is expected to save 161.5 million gallons of fuel per year statewide.

Table 2. Projected Emission Benefits.

	CO ₂ (Calif.) (MMT per yr)	CO ₂ (U.S.)* (MMT per yr)	CO (tons/year)	NO _x (tons/year)	ROG (tons/year)
2020	0.68	1.13 – 4.78	7,659	179	64
2040	1.18	1.96 – 8.30	12,696	297	106

* Potential U.S. benefits assume that automakers choose to use solar management glazing throughout the U.S.

B. Costs

The direct cost of this measure is the increased cost of a vehicle equipped with solar management glazing, plus any increase in window replacement costs over the vehicle life. The cost savings are primarily reduced fuel purchases. The increase in the cost of the vehicle would be a one-time capital cost paid by the consumer. The reduced fuel purchases would be realized over the life of the vehicle.

time. If the interior is less hot, the desired temperature goal will be achieved more quickly; therefore, to attain the same overall air conditioner performance, a smaller (lower kilowatt) air conditioner can be used.

1. Solar Management Glazing Costs

Current glazing ranges from clear glass (i.e., no solar control) for inexpensive vehicles to all-around solar reflective glazing on more expensive European models. The proposed regulation does not require the use of solar reflective glazing. However, to meet the proposed windshield requirements with current technology, a solar reflective approach is likely. While solar reflective glazing generally requires the use of laminated glass, all windshields currently use laminated glass. Thus, the cost for a solar reflective windshield would only reflect the additional cost of the film or coating. For the balance of glazing, the cost will be the cost to move from the current level of solar control (none, light green tinting, solar absorbing glazing) to a glazing that transmits no more than 60 percent of the total solar energy.

In its cost estimates, staff has considered anticipated cost increases suggested by both glazing and vehicle manufacturers. For the first tier (2012) windshield requirement, direct cost estimates provided to staff range from \$15 to \$110 over current glazing, with the typical estimated direct cost of around \$35. Staff used the typical cost of \$35 for our analyses.¹³ For the second tier (2014), anticipated cost increases provided by glazing manufacturers indicate an additional \$10 to \$15 would be expected, for a total increased direct cost from today's baseline cost of up to \$50 for the windshield. Depending on current control levels, cost increases for the other glazing ranges from \$0 to \$33, with an anticipated average cost of \$18 per vehicle (see Appendix C). This results in a total direct cost to the vehicle manufacturer for the tier 2 (2014) requirements of \$68 (\$50+\$18). Derivation of this average can be found in Appendix C.

The \$68 estimated direct cost increase for the solar management glazing reflects the cost that the glass suppliers charge the automobile manufacturers. But there are also indirect costs that the automobile manufacturers may encounter. The automotive industry applies scaling factors to predict the full impact vehicle modifications have on the selling price. A commonly used scaling factor is the retail price equivalent (RPE) multiplier. This RPE multiplier includes both direct and indirect costs. In a recent EPA report (EPA, 2009), an indirect cost multiplier was developed which specifically evaluates the components of indirect costs likely to be affected by vehicle modifications associated with environmental regulation. A range of multipliers accounts for the differences in the technical complexity of the change, and adjusts over time as new technology becomes assimilated into the automotive production process. The underlying concept is that regulations requiring major changes in materials or manufacturing processes, or significant invention of new technology, will likely have a significant impact on indirect costs. In contrast, regulations requiring simple technology modifications may have negligible impacts on indirect costs.

¹³ The estimated cost includes the costs for "deletion areas" in reflective coated windshields to allow the proper operation of electronic devices such as cellular telephones and global positioning systems.

Staff believes that the sidelite, backlite, and roofite requirements in this regulation are low complexity changes. Staff anticipates that they will introduce only minor changes to existing glazing. However, if compliance with the windshield requirements leads to the use of metallic materials that result in electromagnetic attenuation, other associated components might need to be addressed, such as the positioning of antennae and the creation of deletion areas. Therefore, staff proposes a medium complexity multiplier for the windshield, and a low technology multiplier for the balance of glazing. The low complexity multiplier suggested in the EPA analysis is 1.05 in the short term, and 1.02 in the long term. The medium complexity multiplier suggested in the EPA analysis is 1.2 and 1.05. Applying these multipliers would increase the long-term cost assessment for compliant glazing at the tier 2 (2014) level to \$52.50 for the windshield, and \$18.36 for the balance of glazing, for a total adjusted cost to the consumer of around \$71. These cost estimates are summarized in Table 3. Further cost details can be found in Appendix C.

These projected costs to the consumer of up to \$71 could be offset by savings to the manufacturer due to potential downsizing of the air conditioner, and the balance, if any, can be passed on to the consumer.

Table 3. Cost Estimates.

	Windshield		Other Glazing	
	Direct	Total	Direct	Total
First Tier	\$35	\$42 (short-term)	\$18	\$18.90 (short-term)
Second Tier	\$50	\$52.50 (long-term)	n/a	\$18.36 (long-term)
Subtotals (long-term)		\$52.50		\$18.36
Total	\$71			

2. Potential cost to individuals and local/state agencies

Assuming the automobile manufacturers opt to pass on any increased cost for the window glazing to the consumer, individuals and state and local agencies would face an increase of less than one half of one percent in the price of an average vehicle priced at \$20,000. If the purchased vehicle is financed at a rate of five percent, the monthly payment would increase by \$1.34, and the total interest paid over the life of the loan would increase by \$9.39.

Some costs may also be incurred during vehicle ownership. Data indicate that the typical windshield needs to be replaced after an average of 8 years due to damage, and is therefore replaced once during the vehicle's typical useful life. The cost of the windshield to the re-glazer would be increased by up to \$50. Using typical mark-up rates, staff determined an out-of-pocket increased expense for the un-insured consumer of \$150. Staff also assumed the replacement of one sidelite due to breakage at an average increased cost of \$2, corresponding to an increased expense of no more than \$6.

Approximately 80 percent of glazing replacements are covered by insurance. Staff contacted several insurance carriers to determine likely premium increases due to the

use of solar management glazing. Since the use of this glazing would result in increased cost to the insurance company when glazing replacements covered by insurance were made, it seems reasonable that premium increases could result. The carriers staff contacted uniformly agreed that there would be no premium increase resulting from windows with an increased replacement cost of around \$150. Staff also queried on-line providers for custom cars. Using the average new car sales price, and entering “modifications” that increased the car’s value up to \$500 did not change the quoted premium.¹⁴ Various blogs indicated that there is no change in insurance premiums based on the number of window replacement claims. These claims are apparently a very minor part of the financial outlay for an insurance company, and do not merit special attention. Staff concludes that there will be little or no cost impact for insurance premiums as a result of this proposed regulation.

Therefore, staff multiplied the \$156 by the approximately 20% of such window replacements that are not covered by insurance,¹⁵ to generate an average window replacement cost to the consumer of \$31 over the life of the vehicle. Thus, the total cost to an individual over the life of the vehicle is assumed to be \$71 (increased purchase cost) plus \$9 (increased finance cost) plus \$31 (increased replacement glazing cost), for an average total lifetime cost of \$111 per vehicle. Amortized over the expected useful life of the air conditioner system, typically 12 years, generates an annualized cost to the consumer of \$9.25 per year.

These increased costs would be offset by the reduction in fuel use attendant with reduced need for air conditioning. Based on the projections discussed above and in Appendix B, consumers will save an estimated \$16 per vehicle per year in fuel costs. This results in a payback period of around seven years, after which savings will accrue until the vehicle is retired.

3. Administrative Costs

In addition to the costs to supply the glazing, there could be some administrative costs. Glazing suppliers not currently determining the solar performance of their products would need to begin doing so. This likely applies only to low-end suppliers. Once the test procedures are in place, the costs of such tests will be very modest, and will be borne by the suppliers and subsumed within the cost of the product. Records are already retained by vehicle manufacturers, and no additional manufacturer record keeping cost is anticipated.

ARB could also incur costs to implement and enforce the proposed regulation. ARB’s certification section indicated that no additional costs would be incurred to review the additional submittal. However, there may be a small cost to the State to increase ARB’s staff to enforce the rule.

¹⁴ See, for example, www.lelandwest.com.

¹⁵ Eighty percent of window replacements are made under insurance, which will cover solar management materials. Consumers would bear increased replacement costs for the balance of window replacements.

C. Cost-Benefit Assessment

In 2040, anticipated costs are assessed based on the number of affected 2040 model-year vehicles (estimated by EMFAC at around 2.2 million vehicles) times \$111 per vehicle, or \$244.5M and benefits will be 1.18 MMT CO₂. The measure will reduce fuel consumption by 161.5 million gallons per year in 2040. At \$3.67 per gallon (CEC, 2007), this corresponds to an annual economic savings of over \$592.8M. Thus, the proposal results in a net savings of \$372.3M per year, or a savings of \$295 per metric ton CO₂ reduced.

D. Affected businesses

Any business involved in the production or furnishing of automotive glazing could be affected by the proposed regulation. This includes automobile manufacturers, window suppliers, and the re-glazing industry. Manufacturers and glazing suppliers are generally located outside of California. Southwall, Bekaert, and Applied Materials are the only California-based companies of which staff is aware that are producing solar management glazing products. Therefore most impacts to these businesses, both positive and negative, will occur in other states.

This regulation would be expected to have a minimal impact on small business. Small businesses affected by the proposal include most of the window replacement facilities, as well as Southwall and Bekaert. A search of on-line data¹⁶ indicates that there are 1,021 automotive window replacement businesses in California. In addition to these, however, vehicle dealerships are also called upon to replace glass. A similar search indicates there are 2,081 new vehicle dealerships in California. These window replacement businesses, whether small or large, independent or affiliated with a vehicle dealership, will need to use replacement windows that meet the specified performance. The additional cost, if any, for the solar management glazing will be passed on to the insurance company or to the consumer. Solar management windows are expected to be replaced in exactly the same manner as current windows; no additional steps need be taken. No recordkeeping requirements beyond what needs to be done for current inventory needs are anticipated.

Window glazing and film producers will see an increased interest in their solar management glazing products. Total sales of window glass are not expected to change. However, market shifts may occur, so individual businesses may grow or shrink. It is anticipated that Southwall, a California-based small business producing window film, could see an increase in demand for its films, resulting in the additional employment of perhaps a dozen people, and the potential to re-open its manufacturing facility in California. It is expected that personnel and sales at Bekaert and Applied Materials, also California companies, could see a similar benefit, although the exact increase is not known.

Staff believes that two U.S.-based glazing manufacturers are poised to increase market share with this regulation, due to indications that they are further along in the

¹⁶ See www.labormarketinfo.edd.ca.gov.

development of compliant product. These businesses, and any others in a similar situation, may see growth in employees and production. This growth, however, would be offset by reductions in market share for those not so positioned, since the total number of vehicles sold is not expected to change as a result of these proposed regulations. Thus, on a nationwide basis, staff believes that there would be no significant business creation or elimination, although market shifts may occur. However, most window glazing companies will need to improve the solar performance of their product line. To the extent that those businesses or research facilities are located in California, the proposed regulations could lead to the expansion of businesses in California.

Staff believes that there would be no effect on automobile business competitiveness, as all manufacturers selling vehicles in California would need to comply with the proposed regulation. Staff is not aware of any major automobile companies doing business in the U.S. that do not sell vehicles in California.

E. Potential Negative Impacts/Outstanding Issues

Industry raised concerns about potential interference of electromagnetic signals used in sensors and other devices with the use of solar reflective glazing. Staff believes that this issue should be minimized by limiting likely use of this type of glazing to the windshield. Some manufacturers have also expressed the opinion that staff's cost estimates are too low. Staff has received input on costs from both vehicle and glazing manufacturers, and believes its cost estimates to be reasonable.

A concern was raised about the use of the proposed test procedure, primarily relating to the fixed convective coefficients and secondary heat generation from absorption, and their relationship to calculations of total solar energy transmitted (discussed in more detail in Appendix C). An alternate methodology was considered, but the consensus among glass manufacturers whom staff contacted was that the increased accuracy of the alternate method was not worth the complications it would introduce into the calculations of total solar energy transmitted. However, the proposed regulations allow use of an alternative test methodology with Executive Officer prior approval. Manufacturers would have to demonstrate via real-world vehicle testing that the proposed alternative test methodology results in equivalent solar control (i.e., vehicle temperature reduction).

ARB was asked to consider exempting vehicles without air conditioners from these regulations. Currently, approximately 98 percent of passenger cars sold in California are equipped with air conditioning, and about 95 percent of trucks are so equipped. Staff opted for no exemption, because of concerns about aftermarket addition of air conditioning, practicalities of manufacturing and enforcement, and because staff believes there will be an emissions benefit even for vehicles without air conditioners in that if the interior temperature is less hot, the occupant will be less likely to keep the windows down, and therefore the vehicle will be operated in a more aerodynamic manner. Staff believes that the increase in cost will be acceptable to the consumer for the benefit of cooler interiors. Staff was also asked to consider exempting

convertibles from the proposed regulation. Staff is continuing to investigate this issue.

Staff was recently asked to consider exempting non-glass materials such as polycarbonates (i.e., plastic windows) from the proposed requirements. Staff believes that these materials can and should include solar management technologies. Therefore, staff does not believe an exemption is warranted at this time based upon current available information.

VIII. ENVIRONMENTAL JUSTICE

“Environmental Justice” is defined as the fair treatment of people of all races, cultures, and incomes with respect to the development, adoption, implementation, and enforcement of environmental laws, regulations, and policies (Government Code §65040.12(c)). The policies apply to all communities in California but environmental justice issues have been raised more in the context of low-income and minority communities, which sometimes experience higher exposures to some pollutants as a result of the cumulative impacts of air pollution from multiple mobile, commercial, industrial, area-wide, and other sources. Climate change could disproportionately affect low-income communities due to the potential for increased temperatures and other adverse weather phenomena, as well as potential effects on temperature-related issues such as food production and thence, food prices.

Staff believes that this proposal will have minimal adverse environmental justice impacts. The proposal will have only a small impact on the price of a new car (around one half of one percent). The cost increase for the solar management glazing will be offset by reduced fuel use, potentially smaller air conditioner systems, and reduced cost for system recharge due to the smaller size. The original proposal, which proposed the use of solar reflective paint to reduce interior soak temperatures, was reviewed and approved by the Environmental Justice committee. While this revised proposal has somewhat greater costs than the original proposal, its effects on environmental justice communities should not be significantly changed.

IX. REQUIREMENTS OF AB 32

AB 32, at Health and Safety Code section 38562, requires that ARB adopt regulations by January 1, 2010, to implement discrete early action GHG emission reduction measures. These measures must “achieve the maximum technologically feasible and cost-effective reductions in greenhouse gas emissions” from the sources identified for early action measures. AB 32 contains additional standards in Health and Safety Code section 38562 that apply to regulations that will be adopted for general emissions reductions consistent with ARB’s scoping plan. In addition, AB 32 requires that the reductions be real, permanent, quantifiable, verifiable, and enforceable. Furthermore, section 38565 requires the Board to “ensure that the greenhouse gas emission reduction rules, regulations, programs, mechanisms, and incentives under its jurisdiction, where applicable and to the extent feasible, direct public and private investment toward the most disadvantaged communities in California and provide an opportunity for small business, schools, affordable housing

associations, and other community institutions to participate in and benefit from statewide efforts to reduce greenhouse gas emissions.” Staff believes that the cool cars program was developed in accordance with the requirements of AB 32 and has outlined the requirements set forth in sections 38562 and 38565 below.

A. Section 38562

1. Design the regulations, including distribution of emissions allowances where appropriate, in a manner that is equitable, seeks to minimize costs and maximize the total benefits to California, and encourages early action to reduce greenhouse gas emissions.

The proposed regulation utilizes window glazing technology that is believed to be readily achievable in the allotted timeframe in order to maximize benefits and minimize costs. See Sections III (Solar Reflective Glazing) and VII (Environmental and Economic Impacts) for a detailed discussion.

2. Ensure that activities undertaken to comply with the regulations do not disproportionately impact low-income communities.

Passenger vehicles operate throughout California; no disproportionate localized impacts are expected. See Section VIII (Environmental Justice).

3. Ensure that entities that have voluntarily reduced their greenhouse gas emissions prior to the implementation of this section receive appropriate credit for early voluntary reductions.

This requirement is not applicable to the proposed regulation.

4. Ensure that activities undertaken pursuant to the regulations complement, and do not interfere with, efforts to achieve and maintain federal and state ambient air quality standards and to reduce toxic air contaminant emissions.

The proposed regulation would support ARB’s efforts to achieve federal and State standards for criteria pollutants. Vehicles with solar management glazing will consume less fuel and emit fewer greenhouse gases when operating the air conditioner. There are also reductions in criteria pollutants associated with the decreased consumption of fuel. See Section VII (Environmental and Economic Impacts).

5. Consider cost effectiveness of these regulations.

The proposed regulation is expected to result in a net benefit for Californians by reducing fuel consumption and reducing emissions. See Section VII (Environmental and Economic Impacts).

6. Consider overall societal benefits, including reductions in other air pollutants, diversification of energy sources, and other benefits to the economy environment and public health.

The proposed regulation for cool cars is expected to achieve multiple benefits to society and the environment. California would benefit from the reduction of GHG and criteria pollutant emissions that result from vehicles using less fuel for mobile air conditioning. The regulation would also allow the use of smaller air conditioners, containing a lower volume of refrigerants. See Section VII (Environmental and Economic Impacts).

7. Minimize the administrative burden of implementing and complying with these regulations.

The administrative burden of the proposed regulation is expected to be minimal. The proposed regulation requires information to be included in the vehicle owner's manual as to the performance of the glazing utilized in the vehicle. The regulation will require that vehicle manufacturers maintain records of the performance of the glazing utilized in vehicles to be sold in California, and glass replacement facilities to maintain records of glazing installed. See Section VI (Regulatory Proposal).

8. Minimize leakage.

Leakage occurs when an emission limit or regulatory requirement set by the State causes business activities to be displaced outside of California. If leakage were to occur, emissions, jobs and other economic benefits to California would be lost. Leakage is not expected as a result of the proposed regulation.

9. Consider the significance of the contribution of each source or category of sources to statewide emissions of greenhouse gases.

The transportation sector is the largest contributor to the total statewide GHG emissions inventory, producing approximately 38 percent of the state's total GHGs or 179 MMT CO₂e. Emissions from the transportation sector must be significantly reduced in order to achieve 1990 GHG levels by the year 2020. This proposed regulation will reduce the contribution to greenhouse gases from the transportation sector.

The statewide GHG emission benefits of the proposed regulation are projected to be 0.68 MMT CO₂ per year in 2020, increasing to 1.18 MMT CO₂ in 2040. See Section VII (Environmental and Economic Impacts).

B. Section 38565

1. Direct public and private investment toward the most disadvantaged communities in California.

No public investment is anticipated; private investment would occur at already-located facilities for Southwall, Bekaert, and Applied Materials.

2. Provide an opportunity for small business, schools, affordable housing associations, and other community institutions to participate in and benefit from statewide efforts to reduce greenhouse gas emissions.

This proposed regulation will result in all motor vehicles less than or equal to 10,000 pounds GVW using solar management glazing beginning with the 2012 model year. Comfort will be improved for drivers and passengers in these vehicles, and fuel consumption will be reduced.

X. STAFF RECOMMENDATIONS

Staff recommends that the Board adopt, on the basis of the reasons presented, the proposal as set forth within this staff report, and as specifically described in Appendix A.

XI. REFERENCES

- ARB (Air Resources Board). 2004. Staff Report: Initial Statement of Reasons for Proposed Rulemaking, Public Hearing to Consider Adoption of Regulations to Control Greenhouse Gas Emissions from Motor Vehicles. August 6, 2004.
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Attachments

Appendix A. Proposed Regulation and Test Procedures

Appendix B. Emissions Inventory

Appendix C. Additional Information