

**DRAFT**

# EXPANDED LIST OF EARLY ACTION MEASURES TO REDUCE GREENHOUSE GAS EMISSIONS IN CALIFORNIA RECOMMENDED FOR BOARD CONSIDERATION



Lyell Glacier, Yosemite National Park, California, USA circa 1903 (upper) and 2003 (lower)

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The ARB staff is recommending that the Board expand the list of early action measures being pursued to reduce greenhouse gas emissions from 37 to 44 measures. Of these measures staff believes 9 merit consideration to be placed on the list of discrete early actions as defined by the California Global Warming Solutions Act of 2006 (AB 32), increasing the size of the current list of 3 by 6 items. Cumulatively, these 44 measures have the potential to deliver greenhouse gas emission reductions on the order of at least 42 million metric tons of CO<sub>2</sub>-equivalents (MMTCO<sub>2</sub>E) or a quarter of the 2020 emission reductions needed to meet AB 32 goal. Existing ARB regulations will contribute approximately an additional 30 MMTCO<sub>2</sub>E reductions. The Climate Action Team has also identified measures (external to the ARB) that account for a cumulative reduction of approximately 68 MMTCO<sub>2</sub>E. The remaining reductions to meet the 2020 target will be identified by the Scoping Plan due in late 2008. These additional early action recommendations will be presented at a September 17, 2007 public workshop and following consideration of public input will be brought before the Board at its October 25-26, 2007 hearing.

## **EXECUTIVE SUMMARY**

In June 2007 the Air Resources Board (ARB) directed staff to pursue 37 early actions for reducing greenhouse gas (GHG) emissions under the California Global Warming Solutions Act of 2006 (AB 32). The broad spectrum of strategies to be developed – including a Low Carbon Fuel Standard, regulations for refrigerants with high global warming potentials, guidance and protocols for local governments to facilitate GHG reductions, and green ports – reflects that the serious threat of climate change requires action as soon as possible. Three of these 37 identified strategies were also identified as discrete early action measures. These are measures that could be fully adopted as regulations and made effective no later than January 1, 2010, the date established by the Health and Safety Code (HSC) Section 38560.5(b) that requires ARB to adopt discrete early actions.

In addition to approving the 37 GHG reduction strategies, the Board directed staff to further evaluate early action recommendations made at the June 2007 meeting by the AB 32 Environmental Justice Advisory Committee (EJAC), the California Air Pollution Control Officers Association (CAPCOA), and the South Coast Air Quality Management District (SCAQMD), and to report back to the Board within six months. The general sentiment of the Board suggested a desire to try to pursue greater GHG emissions reductions in California in the near-term. This revised early actions report provides staff's analyses of additional emission reduction strategies, and provides recommendations to significantly expand the list of early actions as well as discrete early action measures as identified by HSC Section 38560.5(a).

Since the June 2007 Board hearing, ARB staff has evaluated all 48 recommendations submitted by the EJAC, CAPCOA, and SCAQMD, as well as several other stakeholder suggestions and several internally-generated staff ideas. Each of these measures has been carefully considered with respect to potential emissions reductions, technological feasibility, estimated costs, and economic impacts. This document reports staff's findings and makes further recommendations for a revised list of early actions and, specifically, discrete early action measures (See insert in next page for definitions). The report also provides much greater detail on the evaluation of measures that staff has conducted since the previous April 2007 early actions report<sup>1</sup> was released.

Based on its additional analysis, ARB staff is recommending the expansion of the early action list to a total of 44 measures. The additions to the list of the ARB's commitments also triple the number of measures that would be pursued on an accelerated timeline that meets the AB 32 timeframe for discrete early actions.

In total, as shown in Figure ES-1, the 44 recommended early actions have the potential to reduce GHG emissions by at least 42 million metric tons of carbon dioxide (CO<sub>2</sub>) equivalent (MMTCO<sub>2</sub>E) emissions by 2020, representing about 25% of the estimated reductions needed by 2020. ARB staff is working on 1990 and 2020 GHG emission inventories in order to refine the projected reductions needed by 2020 and expects to present its recommendations to the Board by the end of 2007. The 2020 target reductions are currently estimated to be 174 MMTCO<sub>2</sub>E.

Efforts to develop several of the strategies are already underway with workshops planned for fall 2007 and early 2008. Further, the Climate Action Team (CAT) member agencies<sup>2</sup> are also moving forward with early actions with a targeted reduction of 68 MMTCO<sub>2</sub>E by 2020<sup>3</sup>. Both the ARB and CAT emission reduction projections are best estimates that are subject to revision as additional information on individual measures becomes available. The ARB staff will report on the early actions progress to its Board every six months. The CAT will also periodically update its efforts and progress on a similar schedule.

A list of all 44 early actions is presented in Table 1, with recommended additions as well as the discrete early action measures identified. In addition, the year and quarter in which the ARB Board hearing is anticipated is also indicated. Inclusion of a strategy, regardless of classification or whether it can be implemented before or after the January 1, 2010 enforceability date for discrete early action measures, represents a commitment by the Board to pursue and – for those strategies that meet all legal and technical requirements – bring the measure to the Board on the timeframe illustrated in the table.

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<sup>1</sup> Available at [www.arb.ca.gov/cc/042307workshop/early\\_action\\_report.pdf](http://www.arb.ca.gov/cc/042307workshop/early_action_report.pdf).

<sup>2</sup> Includes the California Environmental Protection Agency, the Business, Transportation and Housing Agency, the Department of Food and Agriculture, the Resources Agency, the Air Resources Board, the Energy Commission, and the Public Utilities Commission.

<sup>3</sup> Those actions are described by the CAT in its companion report on early actions which can be found at [www.climatechange.ca.gov/climate\\_action\\_team/reports/2007-04-20\\_CAT\\_REPORT](http://www.climatechange.ca.gov/climate_action_team/reports/2007-04-20_CAT_REPORT).

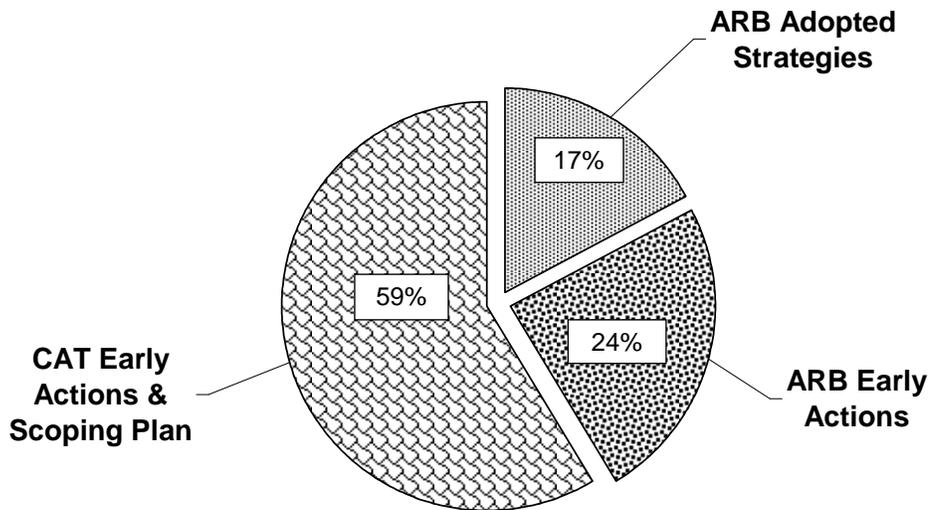


Figure ES-1. 2020 ARB GHG Reduction Estimates by Different Elements of the State's Climate Protection Action Plan.

## BACKGROUND

The California Global Warming Solutions Act of 2006 (AB 32) creates a comprehensive, multi-year program to reduce GHG emissions in California, with the overall goal of restoring emissions to 1990 levels by the year 2020 (see Figure 1). AB 32 recognizes that such an ambitious effort requires careful planning and a comprehensive strategy. By January 1, 2009 the Board must design and adopt an overall Scoping Plan to identify how GHG emissions can be reduced back to 1990 levels by 2020. The Board has until January 1, 2011 to adopt the necessary regulations to implement that plan. Implementation begins no later than January 1, 2012 and the emissions reduction target is to be achieved by January 1, 2020. AB 32 also directs the Board to make recommendations on how to best achieve further reductions beyond 2020.

**Discrete Early Action** – Greenhouse gas reduction measure underway or to be initiated by ARB that meets the AB 32 legal definition as identified by the Health and Safety Code Section 38560.5. Discrete early actions are regulations to reduce greenhouse gas emissions adopted by the Board and enforceable by January 1, 2010.

**Early Action** – Greenhouse gas reduction measures underway or to be initiated by ARB in the 2007 – 2012 timeframe. These measures may be regulatory or non-regulatory in nature.

In April of 2007 ARB staff released a report entitled 'Proposed Early Actions to Mitigate Climate Change in California.' In that report staff proposed 37 early actions to reduce GHG emissions in California with a cumulative estimate in the range of 33-46 MMTCO<sub>2</sub>E by 2020. Existing ARB regulations contributing an additional 30+ MMTCO<sub>2</sub>E (principally the AB 1493 regulations on vehicle GHG emissions) were also discussed. Thus, ARB committed to pursue strategies with the potential to yield over 60 MMTCO<sub>2</sub>E by 2020, representing an important down payment towards the estimated 2020 reduction target. In its April 2007 report staff recommended that three of these strategies be developed on a schedule that met the AB 32 legal requirement for discrete early action measures – the Low Carbon Fuel Standard (LCFS), reduction of refrigerant losses from motor vehicle air conditioning maintenance, and increased methane capture from landfills.

At its June hearing the Board adopted a resolution which listed three discrete early action measures recommended by the staff and also committed ARB to pursue a total of 37 early actions. The Board also directed the staff to further evaluate recommendations for early actions made by the EJAC, CAPCOA, and the SCAQMD, and to report back to the Board within six months. The general sentiment of the Board suggested a desire to try to accomplish greater GHG emissions reductions in California in the near-term. The staff has completed these additional analyses requested by the Board and staff's conclusions and recommendations form the basis of this report. The updated recommendations documented herein will be presented at a September 17, 2007 public workshop at ARB headquarters in Sacramento, and following additional consideration of public input by the staff will be considered by the Board at its October 25-26, 2007 hearing.

Figure 1. Comprehensive Multiyear Program Established by AB 32

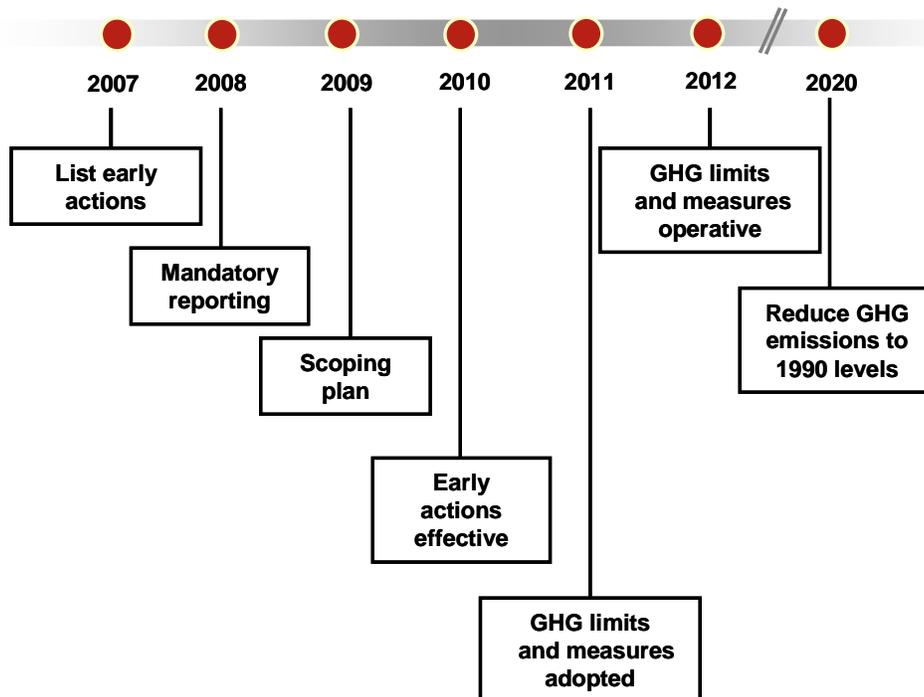


TABLE 1. GHG REDUCTION MEASURES UNDERWAY OR TO BE INITIATED BY ARB IN THE 2007-2012 PERIOD

| EA ID | SECTOR            | STRATEGY NAME  | ARB BOARD HEARING DATE <sup>1</sup> |    |    |      |    |    |      |    |    |      |    |    |      |    |    |      |    |    |    |    |
|-------|-------------------|--|-------------------------------------|----|----|------|----|----|------|----|----|------|----|----|------|----|----|------|----|----|----|----|
|       |                   |  | 2007                                |    |    | 2008 |    |    | 2009 |    |    | 2010 |    |    | 2011 |    |    | 2012 |    |    |    |    |
|       |                   |  | Q1                                  | Q2 | Q3 | Q4   | Q1 | Q2 | Q3   | Q4 | Q1 | Q2   | Q3 | Q4 | Q1   | Q2 | Q3 | Q4   | Q1 | Q2 | Q3 | Q4 |
| 1     | Fuels             | Above ground storage tanks <sup>2</sup>  |                                     |    |    |      |    |    |      |    |    |      |    |    |      |    |    |      |    |    |    |    |
| 2     | Transportation    | Diesel - Offroad equipment (non-agricultural) <sup>2</sup>                           |                                     |    |    |      |    |    |      |    |    |      |    |    |      |    |    |      |    |    |    |    |
| 3     | Forestry          | Forestry protocol endorsement <sup>2</sup>   |                                     |    |    |      |    |    |      |    |    |      |    |    |      |    |    |      |    |    |    |    |
| 4     | Transportation    | Diesel - Port trucks <sup>2</sup>  |                                     |    |    |      |    |    |      |    |    |      |    |    |      |    |    |      |    |    |    |    |
| 5     | Transportation    | Diesel - Vessel main engine fuel specifications <sup>2</sup>                         |                                     |    |    |      |    |    |      |    |    |      |    |    |      |    |    |      |    |    |    |    |
| 6     | Transportation    | Diesel - Commercial harbor craft <sup>2</sup>  |                                     |    |    |      |    |    |      |    |    |      |    |    |      |    |    |      |    |    |    |    |
| 7     | Transportation    | Green ports  |                                     |    |    |      |    |    |      |    |    |      |    |    |      |    |    |      |    |    |    |    |
| 8     | Agriculture       | Manure management (methane diester protocol) <sup>2</sup>                            |                                     |    |    |      |    |    |      |    |    |      |    |    |      |    |    |      |    |    |    |    |
| 9     | Education         | Local government GHG reduction guidance / protocols <sup>2</sup>                     |                                     |    |    |      |    |    |      |    |    |      |    |    |      |    |    |      |    |    |    |    |
| 10    | Education         | Business GHG reduction guidance / protocols <sup>2</sup>                             |                                     |    |    |      |    |    |      |    |    |      |    |    |      |    |    |      |    |    |    |    |
| 11    | Energy Efficiency | Cool communities program <sup>2</sup>  |                                     |    |    |      |    |    |      |    |    |      |    |    |      |    |    |      |    |    |    |    |
| 12    | Commercial        | Reduction of high GWP GHGs used in consumer products <sup>3</sup>                    |                                     |    |    |      |    |    |      |    |    |      |    |    |      |    |    |      |    |    |    |    |
| 13    | Commercial        | Reduction of PFCs from semiconductor industry  |                                     |    |    |      |    |    |      |    |    |      |    |    |      |    |    |      |    |    |    |    |
| 14    | Transportation    | SmartWay truck efficiency  |                                     |    |    |      |    |    |      |    |    |      |    |    |      |    |    |      |    |    |    |    |
| 15    | Transportation    | Low Carbon Fuel Standard (LCFS)  |                                     |    |    |      |    |    |      |    |    |      |    |    |      |    |    |      |    |    |    |    |
| 16    | Transportation    | Reduction of HFC-134a from DIY MVAC servicing  |                                     |    |    |      |    |    |      |    |    |      |    |    |      |    |    |      |    |    |    |    |
| 17    | Waste             | Improved landfill gas capture  |                                     |    |    |      |    |    |      |    |    |      |    |    |      |    |    |      |    |    |    |    |
| 18    | Fuels             | Gasoline dispenser hose replacement <sup>2</sup>                                     |                                     |    |    |      |    |    |      |    |    |      |    |    |      |    |    |      |    |    |    |    |
| 19    | Fuels             | Portable outboard marine tanks <sup>2</sup>  |                                     |    |    |      |    |    |      |    |    |      |    |    |      |    |    |      |    |    |    |    |
| 20    | Transportation    | Standards for off-cycle driving conditions <sup>2</sup>                              |                                     |    |    |      |    |    |      |    |    |      |    |    |      |    |    |      |    |    |    |    |
| 21    | Transportation    | Diesel - Privately owned on-road trucks <sup>2</sup>                                 |                                     |    |    |      |    |    |      |    |    |      |    |    |      |    |    |      |    |    |    |    |
| 22    | Transportation    | Anti-idling enforcement <sup>2,3</sup>   |                                     |    |    |      |    |    |      |    |    |      |    |    |      |    |    |      |    |    |    |    |
| 23    | Commercial        | SF <sub>6</sub> reductions from the non-electric sector <sup>2</sup>                 |                                     |    |    |      |    |    |      |    |    |      |    |    |      |    |    |      |    |    |    |    |
| 24    | Transportation    | Tire inflation program   |                                     |    |    |      |    |    |      |    |    |      |    |    |      |    |    |      |    |    |    |    |
| 25    | Transportation    | Cool automobile paints   |                                     |    |    |      |    |    |      |    |    |      |    |    |      |    |    |      |    |    |    |    |
| 26    | Cement            | Cement (A): Blended cements <sup>3</sup>   |                                     |    |    |      |    |    |      |    |    |      |    |    |      |    |    |      |    |    |    |    |
| 27    | Cement            | Cement (B): Energy efficiency of California cement facilities <sup>3</sup>           |                                     |    |    |      |    |    |      |    |    |      |    |    |      |    |    |      |    |    |    |    |
| 28    | Transportation    | Ban of HFC release from MVAC service / dismantling                                   |                                     |    |    |      |    |    |      |    |    |      |    |    |      |    |    |      |    |    |    |    |
| 29    | Transportation    | Diesel - offroad equipment (agricultural) <sup>2</sup>                               |                                     |    |    |      |    |    |      |    |    |      |    |    |      |    |    |      |    |    |    |    |
| 30    | Transportation    | Add AC leak tightness test and repair to Smog Check                                  |                                     |    |    |      |    |    |      |    |    |      |    |    |      |    |    |      |    |    |    |    |
| 31    | Agriculture       | Collaborative research on GHG reductions from nitrogen land application <sup>3</sup> |                                     |    |    |      |    |    |      |    |    |      |    |    |      |    |    |      |    |    |    |    |
| 32    | Commercial        | Specifications for commercial refrigeration  |                                     |    |    |      |    |    |      |    |    |      |    |    |      |    |    |      |    |    |    |    |
| 33    | Oil and Gas       | Reduction of venting / leaks from oil and gas systems                                |                                     |    |    |      |    |    |      |    |    |      |    |    |      |    |    |      |    |    |    |    |
| 34    | Transportation    | Requirement of low-GWP GHGs for new MVACs <sup>4</sup>                               |                                     |    |    |      |    |    |      |    |    |      |    |    |      |    |    |      |    |    |    |    |
| 35    | Transportation    | Hybridization of medium and heavy-duty diesel vehicles                               |                                     |    |    |      |    |    |      |    |    |      |    |    |      |    |    |      |    |    |    |    |
| 36    | Electricity       | Reduction of SF <sub>6</sub> in electricity generation                               |                                     |    |    |      |    |    |      |    |    |      |    |    |      |    |    |      |    |    |    |    |
| 37    | Commercial        | High GWP refrigerant tracking, reporting, and recovery program <sup>3</sup>          |                                     |    |    |      |    |    |      |    |    |      |    |    |      |    |    |      |    |    |    |    |
| 38    | Commercial        | Foam recovery / destruction program  |                                     |    |    |      |    |    |      |    |    |      |    |    |      |    |    |      |    |    |    |    |
| 39    | Fire Suppression  | Alternative suppressants in fire protection systems                                  |                                     |    |    |      |    |    |      |    |    |      |    |    |      |    |    |      |    |    |    |    |
| 40    | Transportation    | Strengthen light-duty vehicle standards  |                                     |    |    |      |    |    |      |    |    |      |    |    |      |    |    |      |    |    |    |    |
| 41    | Transportation    | Truck stop electrification with incentives for truckers                              |                                     |    |    |      |    |    |      |    |    |      |    |    |      |    |    |      |    |    |    |    |
| 42    | Transportation    | Diesel - Vessel speed reductions <sup>2,5</sup>                                      |                                     |    |    |      |    |    |      |    |    |      |    |    |      |    |    |      |    |    |    |    |
| 43    | Transportation    | Transportation refrigeration - electric standby <sup>2,5</sup>                       |                                     |    |    |      |    |    |      |    |    |      |    |    |      |    |    |      |    |    |    |    |
| 44    | Agriculture       | Electrification of stationary agricultural engines <sup>5</sup>                      |                                     |    |    |      |    |    |      |    |    |      |    |    |      |    |    |      |    |    |    |    |

CUTOFF ADOPTION DATE FOR 01/01/2010 ENFORCEABILITY

= these items are expected to meet the AB 32 definition of discrete early actions in that they directly address GHG emission, are regulatory, and are enforceable by January 1, 2010

<sup>1</sup> Add 9-12 months to Board adoption date to determine the approximate date of Office of Administrative Law (OAL) approval, thereby making a regulation that the Board has adopted legally enforceable.

<sup>2</sup> There is a reasonable expectation that these measures will yield some reductions in emissions impacting climate (e.g., diesel particulate matter, hydrocarbons). However, they are not listed as discrete early actions because they do not directly address greenhouse gases for which the science is most robust (e.g., CO<sub>2</sub>, SF<sub>6</sub>, N<sub>2</sub>O, CH<sub>4</sub>, HFC, PFC), are non-regulatory, or are not enforceable by January 1, 2010.

Some are regulations recently adopted by the Board.

<sup>3</sup> These are additional early actions that were not on the list approved by the Board at its June 2007 hearing.

<sup>4</sup> New requirements for HDVs and other classes not included in AB 1493 to be adopted in 2010. Additional requirements for LDVs to be adopted in conjunction with Pavley II (EA ID 40).

<sup>5</sup> Board hearing is not required or indicated - these measures may be ongoing voluntary efforts or under evaluation by staff with insufficient data to justify setting a Board hearing date at this time.

The ARB is one of many state agencies pursuing early actions. The CAT has identified and is refining additional GHG reduction strategies that can be accomplished or initiated in the 2007-2009 period. The CAT process continues to evolve and grow and its early actions will be indispensable for meeting the 2020 target.

The ARB is also in the process of developing a comprehensive Scoping Plan, due in late 2008, which will outline a multifaceted approach to meeting the 2020 emissions reduction target defined in AB 32. The Scoping Plan will evaluate opportunities for sector-specific reductions, integrate synergistically all ARB and CAT early actions and additional GHG reduction measures by both entities, identify additional measures to be pursued as regulations, and define the role of any potential market mechanisms such as a cap-and-trade program. The analyses of many potential GHG emission reduction strategies that are not recommended as early actions are currently underway and will continue as part of the Scoping Plan development. Recommendations regarding the form of these additional GHG reduction measures (e.g., regulatory, non-regulatory, market-based) will be included in the Scoping Plan.

AB 32 requires that all GHG reduction regulations adopted and implemented by the Board be technologically feasible and cost-effective. The law also requires that GHG measures be structured to prevent negative impacts on emissions of criteria pollutants (e.g., hydrocarbons, particulate matter) and to avoid any disproportionate socioeconomic effects (among other criteria). These are critical considerations for each of the recommended early actions. Staff must address these factors fully as detailed proposals are developed. While staff has advanced its understanding with respect to key requirements that must be addressed for most of the proposed strategies, the analyses have not progressed to the point where all impacts (e.g., technical feasibility, cost-effectiveness) can be defined conclusively at this time. Staff plans to develop this information for each of the early actions brought before the Board. If additional information or analysis reveals that a particular measure cannot meet one or more of these requirements, it will not be put into effect. The actual design or features of each measure will be crafted through an open public process that includes interaction with interested stakeholders through various means including workshops.

## **CONSIDERATION OF STAKEHOLDER INPUT**

### Sources of Additional Strategies

As directed by the Board, ARB staff further evaluated early action recommendations from the EJAC, CAPCOA, and SCAQMD as presented at the June 2007 Board Meeting. The original submissions from these entities are included in Appendix A to this report. A brief summary of recommendations from these three sources is as follows:

- The EJAC submitted 34 recommendations for early actions. Of these, 21 were approved by the Board at its June 2007 hearing. Thirteen strategies were not on the list approved by the Board at its June hearing. These are evaluated in Appendix B.

- The CAPCOA submitted five broad suggestions regarding early actions. These and a sixth suggestion are also addressed in the strategy evaluations presented in Appendix B.
- The SCAQMD submitted eight suggestions pertaining to early actions, each of which was further evaluated by ARB staff as documented in Appendix B.

In addition to the items from these three sources, ARB staff has also evaluated additional potential early actions since the June 2007 Board meeting. These measures were either stakeholder suggestions or were items generated internally. There were also several measures approved by the Board at its June 2007 hearing that have direct climate benefits but were not addressed via the EJAC, CAPCOA, SCAQMD, or additional stakeholder suggestions summarized above that are further evaluated in this report. A list of all 63 items considered from these various sources may be found in Table 2 of this document. The results of the staff analysis for each of the strategies evaluated are included in Appendices B and C as indicated in the 'Summary Number' column of Table 2. For those items in Table 2 that are included in the list of previously approved or newly recommended early actions in Table 1, their Early Action ID number from Table 1 is also provided as a cross-reference.

There were several early actions approved by the Board at its June 2007 hearing which were not evaluated further by the ARB (as the rationale for them was documented in the April 2007 report). These include the three discrete early action measures – specifically the LCFS, reduction of refrigerant losses from motor vehicle air conditioning maintenance, and increased methane capture from landfills – currently approved by the Board. Additionally, some air pollution control measures that have been approved by the Board with potential GHG reductions or other climate co-benefits (e.g., diesel control measures and hydrocarbon emission standards) have not been further evaluated by staff as their primary rationale was already established.

### Staff Analysis of Strategies

Based on the direction from the Board, significant staff effort was expended to increase the depth and breadth of the analysis afforded to the strategies suggested by stakeholders. For each candidate early action measure analyzed, staff's recommendation concerning identification as an early action was based on a consideration of potential emissions reductions, estimated costs and economic impacts, the impacted sectors / entities, technological feasibility, and any additional information available. Completion of a full analysis for each of these factors was the goal for each strategy evaluated. However, as a comprehensive assessment will take at least several months for many strategies, much of the desired information is very preliminary or not currently available for a number of measures. Each staff evaluation sought to address:

TABLE 2. GHG REDUCTION STRATEGIES FURTHER EVALUATED BY THE ARB

| SUMMARY NUMBER | TBL 1 EA ID               | SOURCE      | SECTOR         | STRATEGY DESCRIPTION  | DISPOSITION                               |
|----------------|---------------------------|-------------|----------------|---|---|
| NA             | 17                        | EJAC        | Waste          | Landfill methane gas recapture<br>CAPCOA recommendations  | No Change in Classification               |
| Appendix B01   | --                        | CAPCOA      | Government     | 1. Prioritize SIP reductions to maximize GHG reductions<br>2. Local rules / potential statewide measures to ID early actions<br>3. Existing permit programs for significant stationary sources<br>4. Develop guidance on review and mitigation of GHGs under CEQA<br>5. Local air district coordinated voluntary programs | Further Evaluation Required               |
| Appendix B02   | 37                        | EJAC        | Transportation | Refrigerant tracking, reporting and recovery program  | Add as an EA                              |
| Appendix B03   | 8                         | EJAC        | Agriculture    | Manure digester protocol for calculating greenhouse gas mitigation  | No Change in Classification               |
| Appendix B04   | 33                        | EJAC        | Oil and Gas    | Reduce methane venting/leaks from oil and gas systems   | No Change in Classification               |
|                |                           |             | Oil and Gas    | Recycling of waste gases at oil production sites  |   |
|                |                           |             | Oil and Gas    | Eliminate methane exemptions granted to oil production sites  |   |
| Appendix B05   | 14                        | EJAC        | Oil and Gas    | Energy efficiency measures at oil production sites  | Re-classify as a Discrete EA Measure      |
| STAKEHOLDER    | SmartWay truck efficiency |             |                |   |   |
| Appendix B06   | 25                        | EJAC        | Transportation | Cool paints for automobiles   | No Change in Classification               |
| Appendix B07   | 7                         | EJAC/SCAGMD | Commercial     | Green ports   | Re-classify as a Discrete EA Measure      |
|                |                           | EJAC        | Commercial     | Shoreside generators / electrical hookup  |   |
| Appendix B08   | 43                        | SCAGMD      | Transportation | Auxiliary ship engine cold ironing  | No Change in Classification               |
| Appendix B09   | 41                        | EJAC        | Transportation | Transport refrigeration units, electric standby   |   |
| Appendix B10   | 24                        | EJAC        | Transportation | Truck stop electrification with incentives for truckers   | No Change in Classification               |
| Appendix B11   | 34                        | EJAC        | Transportation | Tire pressure program   | Re-classify as a Discrete EA Measure      |
| Appendix B12   | 30                        | EJAC        | Transportation | Requirement of low-GWP GHGs for new MACS  | No Change in Classification               |
| Appendix B13   | --                        | EJAC        | Cement         | Addition of AC leak test and repair requirements to Smog Check  | No Change in Classification               |
| Appendix B14   | --                        | EJAC        | Cement         | WAFFLEMAT Systems   | Evaluating for Scoping Plan               |
| Appendix B15   | --                        | EJAC        | Commercial     | Green ship incentive program  | Evaluating for Scoping Plan               |
| Appendix B16   | --                        | EJAC        | Commercial     | Anti-idling requirement for cargo handling equipment at ports   | Evaluating for Scoping Plan               |
| Appendix B17   | --                        | EJAC        | Transportation | Electrification of airport ground support equipment   | Evaluating for Scoping Plan               |
| Appendix B18   | 35                        | EJAC        | Commercial     | Electrification of construction equipment at urban sites  | Addressed via recently adopted regulation |
| Appendix B19   | 25                        | STAKEHOLDER | Transportation | Hybridization of medium and heavy-duty vehicles   | No Change in Classification               |
|                |                           | Cement      | Cement         | Cement (A): Energy efficiency of California cement facilities   |   |
|                |                           | EJAC        | Cement         | Relatively inexpensive energy savings measures with short pay back times for cement industry  |   |
| Appendix B20   | --                        | EJAC        | Cement         | Low carbon fuels for cement production  | Add as an EA                              |
| Appendix B21   | --                        | EJAC        | Cement         | Cement (B): Blended cements   | Add as an EA                              |
|                |                           | EJAC        | Oil and Gas    | Relatively inexpensive energy savings measures with short pay back times for fossil fuel power plants built prior to 1980   |   |

TABLE 2. GHG REDUCTION STRATEGIES FURTHER EVALUATED BY THE ARB  
(continued)

| SUMMARY NUMBER | TBL 1 EA ID | SOURCE        | SECTOR            | STRATEGY DESCRIPTION   | DISPOSITION                          |
|----------------|-------------|---------------|-------------------|--|--------------------------------------|
| Appendix B22   | --          | EJAC          | Oil and Gas       | Identify and implement energy efficiency measures at refiners that include, but are not limited to, conducting an energy audit | Evaluating for Scoping Plan          |
|                |             | EJAC          | Oil and Gas       | Recycle waste gases at refineries  |                                      |
|                |             | EJAC          | Oil and Gas       | Energy efficiency measures at refineries   |                                      |
| Appendix B23   | --          | EJAC          | Commercial        | Accelerate the replacement of cargo handling equipment at ports  | Evaluating for Scoping Plan          |
| Appendix B24   | --          | EJAC          | Agriculture       | Evaluate enclosed dairy barns as an additional strategy for the capture and combustion of methane emissions at dairies         | Evaluating for Scoping Plan          |
| Appendix B25   | --          | EJAC          | Commercial        | Composting – adopt South Coast and San Joaquin rules statewide   | Evaluating for Scoping Plan          |
| Appendix B26   | --          | EJAC          | Electricity       | Phase out pre-1980 power plants generating at least 100 MW and provide incentives to replace them with clean energy            | Evaluating for Scoping Plan          |
| Appendix B27   | --          | EJAC          | Electricity       | Prohibit fuel oil burning in pre-1980 power plants generating at least 100 MW  | Evaluating for Scoping Plan          |
| Appendix B28   | --          | EJAC          | Oil and Gas       | Refinery methane emissions   | Evaluating for Scoping Plan          |
| Appendix B29   | 32          | CAPCOA        | Commercial        | Specifications for commercial refrigeration  | No Change in Classification          |
| Appendix B30   | --          | SCAQMD        | Transportation    | Accelerate introduction and deployment of light-duty vehicle (passenger) hybrid technology                                     | Evaluating for Scoping Plan          |
| Appendix B31   | --          | SCAQMD        | Oil and Gas       | Natural Gas requirement of 1960 Wobbe Index  | Further Evaluation Required          |
| Appendix B32   | 11          | SCAQMD        | Energy Efficiency | Cool communities program   | No Change in Classification          |
| Appendix B33   | 40          | SCAQMD        | Transportation    | Strengthen light-duty vehicle standards  | No Change in Classification          |
| Appendix B34   | --          | SCAQMD        | Transportation    | Off Highway Recreational Vehicle (OHRV) evaporative emissions control  | Further Evaluation Required          |
| Appendix B35   | --          | SCAQMD        | Transportation    | Determination of evaporative emissions from Pleasure Craft   | Further Evaluation Required          |
| Appendix B36   | 42          | ARB           | Transportation    | Vessel speed reduction   | No Change in Classification          |
| Appendix B37   | 22          | STAKEHOLDER   | Transportation    | Anti-idling enforcement  | Add as an EA                         |
| Appendix B38   | 23          | ARB           | Commercial        | SF <sub>6</sub> reductions from the non-electric sector  | Add as a Discrete EA Measure         |
| Appendix B39   | 12          | ARB           | Commercial        | Reduction of high GWP GHGs used in consumer products   | Add as a Discrete EA Measure         |
| Appendix B40   | 31          | ARB           | Agriculture       | Collaborative research to understand how to reduce GHG emissions from nitrogen land application                                | Add as an EA                         |
| Appendix C01   | 44          | ARB EA REPORT | Agriculture       | Stationary agricultural engine electrification   | No Change in Classification          |
| Appendix C02   | 13          | ARB EA REPORT | Commercial        | Reduction of perfluorocarbons (PFCs) from the semiconductor industry   | Re-classify as a Discrete EA Measure |
| Appendix C03   | 38          | ARB EA REPORT | Commercial        | Foam recovery / destruction program  | No Change in Classification          |
| Appendix C04   | 9           | ARB EA REPORT | Government        | Guidance and protocols for local governments to facilitate GHG emission reductions   | No Change in Classification          |
| Appendix C05   | 10          | ARB EA REPORT | Business          | Guidance/protocols for businesses to facilitate GHG emission reductions  | No Change in Classification          |
| Appendix C06   | 36          | ARB EA REPORT | Commercial        | Reduce sulfur hexafluoride (SF6) from electrical generation  | No Change in Classification          |
| Appendix C07   | 39          | ARB EA REPORT | Commercial        | Alternative suppressants in fire protection systems  | No Change in Classification          |
| Appendix C08   | 3           | ARB EA REPORT | Forestry          | Forestry protocol endorsement  | No Change in Classification          |
| Appendix C09   | 28          | ARB EA REPORT | Transportation    | Enforcement of federal ban on HFC release during service/dismantling of MVACs  | No Change in Classification          |

- The potential emission reductions in 2010 (if any) and 2020 in terms of million metric tons of CO<sub>2</sub>-equivalent per year, including any co-benefits (e.g., reduction in emissions of criteria pollutants) or disbenefits (e.g., fuel penalty).
- The costs per MTCO<sub>2</sub>E and the total cost of implementation in 2010 (if applicable) and 2020 and the sectors that will bear the costs including any potential disproportionate impacts on small businesses or environmental justice sectors of the community. This discussion includes businesses or individuals (e.g., environmental justice community) that may be adversely impacted by the proposed strategy.
- The likely technical feasibility of the technology by describing the degree to which it or a similar technology has already been proven. If not applicable, the research/pilot studies that suggest the technological feasibility is likely to be within the next few years are cited.
- Additional considerations that pertain to the measure, such as if any other jurisdiction (state, county) has taken the action, whether the item falls under ARB jurisdiction or is a CAT strategy, whether ARB has legal authority, whether the item would be regulatory, when the item could be taken before the Board, and coordination with affected entities, trade associations, and/or government agencies.

### Current State of Understanding

Appendices B and C include a complete listing of staff's analysis for each of the 63 recommendations / potential early actions listed in Table 2, exclusive of the landfill methane capture suggestion by the EJAC, which is already a discrete early action. Each summary has a unique identification number that is also listed in Table 2 for each measure; note that multiple measures may be addressed by the same summary.

The summaries in Appendices B and C represent ARB staff's current understanding of the ideas evaluated. It is acknowledged that in many instances, additional time, effort, and information are still needed for a more thorough compilation of all relevant and necessary information to support development as a regulation or other approach such as guidance.

Based on its current state of understanding, staff has made one of six recommendations for each measure it evaluated which are described below. One of these six recommendations is indicated for each of the strategies evaluated (see disposition column in Table 2).

- Previously Approved – No Change – applies to measures which were approved by the Board as early actions at its June 2007 hearing. Based on further evaluation by staff, no change in the classification of this early action is recommended.

- Previously Approved – Reclassify as a Discrete Early Action – applies to measures which were approved by the Board as early actions at its June 2007 hearing. Based on further evaluation by staff, it is recommended that this early action be reclassified as a discrete early action measure.
- Proposed Measure – Add as a Discrete Early Action – applies to measures which are recommended for addition to the list of discrete early action measures.
- Proposed Measure – Add as an Early Action – applies to measures which are recommended for addition to the list of early actions.
- Proposed Measure – Continue to Evaluate in Scoping Plan – applies to measures proposed at the June 2007 Board meeting which are recommended for further evaluation in the Scoping Plan. A draft Scoping Plan is expected by mid-2008 and must be considered by the Board prior to January 1, 2009. Evaluation as part of the Scoping Plan provides the most effective approach for fully considering these recommendations.
- Proposed Measure – Further Evaluation Needed – applies to measures proposed that require further information and evaluation prior to recommending that they be pursued as early actions. As additional information becomes available staff will consider whether it supports recommending these strategies as additions to the Board's list of commitments for reducing greenhouse gas emissions.

## **RECOMMENDATIONS FOR ADDITIONAL EARLY ACTIONS**

The ARB staff is recommending that a total of 44 early actions be developed and brought to the Board for future consideration. These measures are recommended because staff's evaluation concluded that they are expected to yield significant GHG emission reductions, are likely to be cost-effective and technologically feasible, and can be brought back to the Board as full proposals in the 2007-2012 timeframe. Specifically, staff is recommending that 6 more discrete early actions be added to the list previously approved by the Board, two of which are new recommendations to be added to the list of those actions meeting the narrow definition of discrete early actions in that they are regulatory and will be enforceable by January 1, 2010. Furthermore, staff is recommending that 4 previously adopted early actions be reclassified as discrete early action measures. Cumulatively, these 44 total recommendations are expected to yield at least 42 MMTCO<sub>2</sub>E reductions by 2020, representing about 25% of the 2020 target.

### Summary of Items Reviewed

Table 2 lists each of the items evaluated as potential early actions. It consists of the recommendations made by the EJAC, CAPCOA and the SCAQMD as well as additional strategies that were identified by stakeholders or ARB staff. Each of the strategies has been evaluated with the results of the evaluation presented in

Appendices B and C. The 'Summary ID' column of Table 2 cross-references each of these items to its summary in the appendices; the final disposition of each item is listed in the 'Disposition' column.

### Items Addressed by Recently Adopted Regulations

The ARB recently adopted an off-road diesel rule<sup>4</sup> at its July 2007 Board hearing. This regulatory measure was not listed as an early action in the April 2007 ARB staff report. The regulation requires a reduction in off-road diesel engine particulate matter emissions, and is applicable to off-road engines such as those used by urban construction equipment. A possible way to achieve such pollutant reductions is via the electrification of construction equipment at urban sites. This particular example was submitted by the EJAC [refer to summary number B17 in Appendix B]; this recommendation is therefore encapsulated within the intent of a recently adopted regulation and was not further evaluated as part of the early action effort.

### Measures Recommended as Additional Discrete Early Actions

The ARB staff's recommendations concerning the addition of discrete early actions are summarized below. In addition to these measures staff closely evaluated many other measures as potential discrete early action measures. However, for reasons such as the non-regulatory nature of a measure, its implementation timeline, and others, they are not recommended for addition to the list of discrete early action measures. Additional information, including the specific rationale for the disposition of each strategy evaluated, may be found in Appendices B or C and is summarized in Table 2.

*SF<sub>6</sub> Reductions in the Non-Electric Sector.* This measure is recommended as an additional discrete early action measure. The strategy involves the potential ban of SF<sub>6</sub> in non-utility, non-semiconductor applications where safe, cost-effective alternatives are available. These applications may include magnesium production and casting operations, air quality tracer gas studies, and face velocity tests for laboratory hoods. The staff will investigate other possible uses of SF<sub>6</sub> during the development of the regulations.

*Reduction of High GWP GHGs in Consumer Products:* This measure is recommended as an additional discrete early action measure. The strategy involves the reduction of high-GWP GHGs used as propellants in aerosol products, tire inflators, electronics cleaning, dust removal, hand held sirens, hobby guns (compressed gas), party products (foam string), and other formulated consumer products when viable alternatives are available. Some data regarding emissions of greenhouse gases are available from a recent survey of consumer products, which may represent possible reductions within the discrete early action timeframe. Manufacturers are also currently being surveyed to determine the extent of usage of high GWP gases in several more categories of consumer products. These future survey results may lead to additional strategies with

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<sup>4</sup> Staff report located at <http://www.arb.ca.gov/regact/2007/ordiesl07/isor.pdf>

emission reduction potential that can be pursued after the deadline for discrete early action items.

### Measures Recommended for Reclassification as Discrete Early Actions

The ARB staff's recommendations concerning the reclassification of pre-existing early actions are summarized below. Additional information, including the specific rationale for the disposition of each strategy evaluated, may be found in Appendices B or C and is summarized in Table 2.

*SmartWay Truck Efficiency:* This measure is recommended to be re-classified as a discrete early action measure. The strategy involves requiring existing trucks/trailers to be retrofitted with the best available "SmartWay Transport"<sup>5</sup> and/or ARB approved technology. Technologies that reduce GHG emissions from trucks may include devices that reduce aerodynamic drag and rolling resistance. Aerodynamic drag may be reduced using devices such as cab roof fairings, cab side gap fairings, cab side skirts, and on the trailer side, trailer side skirts, gap fairings, and trailer tail. Rolling resistance may be reduced using single wide tires or low-rolling resistance tires and automatic tire inflation systems on both the tractor and the trailer.

*Tire Inflation Program:* This measure is recommended to be re-classified as a discrete early action measure. The strategy involves actions to ensure that vehicle tire pressure is maintained to manufacturer specifications. Specifically, the strategy seeks to ensure that tire pressure in older vehicles is monitored by requiring that tires be checked and inflated at regular service intervals. One potential approach would be to require all vehicle service facilities, such as dealerships, maintenance garages, and smog check stations, to check and properly inflate tires. It is also anticipated that signage at fueling stations clearly indicate the availability of compressed air at no charge. Staff also recommends that the feasibility of conducting an extensive outreach program be investigated.

*Reduction of PFCs from the Semiconductor Industry:* This measure is recommended to be re-classified as a discrete early action measure. The strategy involves establishing a PFC emissions reduction goal and determining measures to achieve that goal. There are several approaches the industry has either employed or committed to continue evaluating to reduce PFC emissions from semiconductor production, including process optimization (optimizing the use of PFCs, such as in the chamber cleaning process), alternative chemistry

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<sup>5</sup> The United States Environmental Protection Agency (U.S. EPA) in collaboration with the freight industry has developed a voluntary program designed to increase energy efficiency while significantly reducing greenhouse gases and criteria pollutants. The program, known as the SmartWay Transport Partnership (SmartWay Transport), encourages trucking companies to use technologies that improve efficiency and reduce emissions. The SmartWay Transport also designates highly efficient and emission reduction technology packages as SmartWay Upgrade Kits which can be purchased at various SmartWay partner centers, dealerships, and service centers.

(<http://www.epa.gov/otaq/smartway/documents/420f07027.htm>)

development, emissions abatement; and recovery/recycling (separation of fluorinated compounds from other gases for further processing and reuse).

*Green Ports:* This measure is recommended as an additional discrete early action measure. The strategy involves providing an alternative source of power for ships while they are docked. For example, the ships can use cables to receive electricity from the shore, thereby allowing them to shut off their auxiliary engines, reducing emissions of air pollutants. Staff proposes to present the draft regulation to the Board as a measure to reduce nitrogen oxides (NO<sub>x</sub>) and diesel particulate (PM) emissions and to quantify the associated (carbon dioxide) CO<sub>2</sub> emission reductions. By focusing on NO<sub>x</sub> and PM reductions, staff will address the local and regional health impacts of ships docked in California's ports, including any disproportionate impacts those emissions may have on surrounding communities.

### Measures Recommended as Additional Early Actions

The ARB staff's recommendations concerning the addition of early actions are summarized below. In addition to these recommendations staff closely evaluated many other measures such as a green ship incentive program, and refinery methane emission reductions. However, for reasons such as a substantial lack of available information, technological barriers, implementation timeline, and others, they are not recommended for addition to the list of early actions. Additional information, including the specific rationale for the disposition of each strategy evaluated, may be found in Appendices B or C and is summarized in Table 2.

*Refrigerant Tracking, Reporting, and Recovery Program:* This measure is recommended as an additional early action. The strategy involves the reduction of emissions of high GWP GHGs through establishing requirements for enhanced monitoring, enforcement, reporting, and recovery. It may be determined that more than one strategy is required to effectively address the sources of interest and that the strategy or strategies are likely to include both regulatory and non-regulatory elements. Such strategies could include:

- Refrigerant Recovery from Decommissioned Refrigerated Shipping Containers: This consists of an assessment of the magnitude of the emissions from refrigerated shipping containers. Depending on results, the strategy may be similar to the one enforcing the federal ban on releasing refrigerants to the atmosphere from the servicing or dismantling of MVACS. After the recovery from a decommissioned container, it may be desirable to disable the refrigeration unit as well, which may require a regulation.
- Residential Refrigeration Program: This involves supporting existing voluntary programs to promote the upgrade of residential refrigeration equipment in need of repair, such as refrigerators and freezers. The program could potentially be expanded to include window unit air conditioners.

- High-GWP Refrigerant Tracking, Reporting, and Deposit Program: This strategy involves 1) expanding and enforcing the national ban on venting high-GWP GHGs (including fully emissive processes) during equipment/process lifetime; 2) requiring high-GWP GHG sales, use and energy use reporting as well as inspection and maintenance (I/M) and leak repair for equipment, cylinders, products, or systems with capacities above some CO<sub>2</sub>E threshold; 3) requiring technician certification for sales, purchase, transport, recovery, reclamation, resale, I/M; and 4) establishing a high-GWP GHG deposit program and/or fines for emissive processes or leaky systems.

*Cement (A): Energy Efficiency of California Cement Facilities*: This measure is recommended as an additional early action. The strategy involves reducing CO<sub>2</sub> emissions from fuel combustion, calcination, and electricity use by converting to a low-carbon fuel-based production, decreasing fuel consumption, and improving energy efficiency practices and technologies in cement production.

*Cement (B): Blended Cements*: This measure is recommended as an additional early action. The strategy to reduce CO<sub>2</sub> emissions involves the addition of blending materials such as limestone, fly ash, natural pozzolan and/or slag to replace some of the clinker in the production of Portland Cement. Currently, ASTM cement specifications allow for replacement of up to 5% clinker with limestone. Most manufacturers could in fact replace up to 4% with limestone. Caltrans allows for 2.5% average limestone replacement until testing of the long term performance of the concrete is complete. Caltrans currently has over \$1 million in task orders and is devoting considerable staff resources to the evaluation of limestone blending in cement. Caltrans also currently has standards for using flyash and slag in concrete. Other blending practices will be explored.

*Anti-idling Enforcement*: This measure is recommended as an additional early action. The strategy guarantees emission reductions as claimed by increasing compliance with anti-idling rules, thereby reducing the amount of fuel burned through unnecessary idling. Measures may include enhanced field enforcement of anti-idling regulations, increased penalties for violations of anti-idling regulations, and restriction on registrations of heavy-duty diesel vehicles with uncorrected idling violations.

*Collaborative research to understand how to reduce GHG emissions from nitrogen land application*: This measure is recommended as an additional early action. The strategy involves the identification of methodologies for better characterizing California's nitrogen cycle. An important first step to better characterizing the relationship between nitrogen land application and nitrous oxide formation in California agriculture, landscaping and other uses as well as opportunities for emission reductions is a collaborative research effort with stakeholders. The research is expected to focus on identifying optimal ways to reduce nitrous oxide emissions while increasing soil retention of nitrogen for plant uptake. As part of

the research the ARB will collaborate with the California Department of Food and Agriculture, Department of Pesticide Regulation, commodity groups, and other stakeholders. The research is expected to ultimately support the development of guidance to improve the characterization of nitrous oxide emissions from nitrogen land applications as well as identify effective strategies for emission reductions.

### Process Forward for Regulatory Items

All discrete early action measures and the majority of the other early actions will enter into the conventional regulatory development process. This process involves public workshops and the consideration of stakeholder input, followed by the formal regulation development, which includes a public hearing where the Board considers the staff recommendation. If the Board adopts the regulation or an amended regulation, then it must be reviewed and approved by the Office of Administrative Law (OAL) before becoming law. Though the non-regulatory strategies such as guidelines will not become binding mandates, they will go through a similar process of public participation. This open process ensures that the regulatory development of each strategy that the staff recommends to the Board is informed by the best and most up-to-date information.

### **ADDITIONAL CONSIDERATIONS / CAT STRATEGIES**

ARB has or will be adopting several strategies not discussed explicitly in this report that will yield significant GHG reductions by 2020. Most notably, the regulation that the Board adopted in response to AB 1493, which mandated the reduction of greenhouse gas emissions from passenger vehicles, is expected to account for 30 MMTCO<sub>2</sub>E by 2020. Other diesel PM, ozone-precursor, and State Implementation Plan (SIP) measures are also expected to have climate co-benefits whose magnitudes are yet to be determined.

In its April 2007 draft report entitled 'Climate Action Team Proposed Early Actions to Mitigate Climate Change in California', the CAT identified early actions external to the ARB that may yield up to 68 MMTCO<sub>2</sub>E reductions by 2020. In addition to ARB, members of the CAT have begun work on implementing many of the strategies outlined in the April 2007 draft report. Although not under statutory mandate to do so, the other CAT members expect to have several items implemented through regulations by January 1, 2010; these 13 strategies are expected to result in emission reductions of approximately 7 MMTCO<sub>2</sub>E with some reduction estimates still to be calculated. The same CAT members have also identified 41 additional measures for the post-2010 timeframe, which are expected to yield reductions in greenhouse gas emissions on the order of 61 MMTCO<sub>2</sub>E by 2020.

The ARB is in the process of developing a comprehensive Scoping Plan, due in late 2008, which will outline the multifaceted approach to meeting the 2020 emissions reduction target required by AB 32. The Scoping Plan will evaluate opportunities for sector-specific reductions, integrate synergistically all ARB and CAT early actions and additional GHG reduction measures, and define the role of any potential market mechanisms. The analyses of many potential GHG emission reduction strategies that

are not recommended as early actions are currently underway and will continue as part of the Scoping Plan development. Recommendations regarding the form of these additional GHG reduction measures (e.g. regulatory, non-regulatory, market-based) will be included in the Scoping Plan.

## **CONCLUSIONS / RECOMMENDATIONS**

At its June 2007 hearing, the Board asked staff to conduct additional analyses of stakeholder suggestions for early actions. Staff has completed this task as well as the further evaluation of additional potential early action measures, and recommends that the list of early action measures be expanded to 44. Nine of these strategies meet the AB 32 definition of discrete early action measures, which is three times the number of original discrete early action measures currently approved by the Board. The ARB recognizes that California must act quickly and decisively now to begin the long road to mitigating the most serious impacts of global warming, and is committed to pursuing the full list of 44 early actions.

The revised list of early actions as recommended by ARB staff is a more ambitious plan than originally proposed and is a complement to the actions of the Climate Action Team members and many other entities in California, the U.S., and the world who are acting now for climate protection. Discrete early action measures that will be in place and enforceable by 2010 include the original list of 3 strategies, plus an additional 6 measures in the transportation and commercial sectors. In addition, 5 new measures as suggested by stakeholders or staff analysis will also be pursued as early actions, but will be implemented post-2010 or are not necessarily regulatory in nature. Cumulatively, all 44 early actions have the potential for reductions of 42 MMTCO<sub>2</sub>E by 2020.

The revised early action plan is a comprehensive framework of regulatory and non-regulatory elements that will result in significant and effective GHG emission reductions. The revised early action plan will receive public input at a September 17, 2007 workshop and will be considered by the Board at its October 25-26, 2007 hearing. If approved, each early action will be developed through an open public process.

## GLOSSARY OF TERMS AND ACRONYMS

**AB 32** – Assembly Bill 32, the Global Warming Solutions Act of 2006

**ARB** – Air Resources Board

**CAPCOA** – California Air Pollution Control Officers Association

**CAT** – Climate Action Team, a committee of multiple state agencies led by the Secretary of Cal/EPA

**CO<sub>2</sub>** – carbon dioxide; a byproduct of fossil fuel combustion, cement production, and other natural processes

**Discrete Early Actions** – Greenhouse gas reduction measure underway or to be initiated by ARB that meets the AB 32 legal definition as identified by the Health and Safety Code Section 38560.5. Discrete early actions are regulations to reduce greenhouse gas emissions adopted by the Board and enforceable by January 1, 2010.

**Early Actions** – Greenhouse gas reduction measures underway or to be initiated by ARB in the 2007 – 2012 timeframe. These measures may be regulatory or non-regulatory in nature.

**EJAC** – Environmental Justice Advisory Committee

**GHG** – greenhouse gas or gases; defined in AB 32 as including carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride; also known as “the Kyoto six”

**GWP** – global warming potential, the relative warming of a greenhouse gas as compared to carbon dioxide which has a GWP of 1.0.

**HFCs** – Hydrofluorocarbons; a class of compounds whose molecules consist of carbon, hydrogen, and fluorine atoms typically used in air conditioning systems and as propellants

**HSC** – (the California) Health and Safety Code

**LCFS** – Low Carbon Fuel Standard

**MMTCO<sub>2</sub>E** – million metric tons (of) carbon dioxide equivalent (gases)

**MVAC** – motor vehicle air conditioning (systems)

**OAL** – California Office of Administrative Law

**OHRV** – Off Highway Recreational Vehicle

**PFCs** – perfluorocarbons, a class of compounds derived from hydrocarbons by replacement of hydrogen atoms by fluorine atoms. PFCs are made up of atoms of carbon, fluorine, and/or sulfur, and are mostly used in the semi-conductor industry

**SCAQMD** – South Coast Air Quality Management District

**SF<sub>6</sub>** – sulfur hexafluoride; a highly stable non-conducting chemical used for and emitted from various industrial processes and in the manufacturing of electrical circuitry

**APPENDIX A – EJAC, CAPCOA, and SCAQMD Recommendations**

**ARB Discrete Early Action Measures  
as proposed by  
the Environmental Justice Advisory Committee on the Implementation of the  
Global Warming Solutions Act of 2006**

| Number | Description  |
|--------|--|
| 1      | Improved landfill methane capture  |
| 2      | Require HFC-134a reductions through evaluation of refrigerants in de-commissioned or stored cargo containers, commercial and residential HVAC system leakage, auto dismantling/crushing facilities (i.e., requiring HFCs be removed from cars prior to scrapping)                      |
| 3      | Manure management <sup>1</sup>   |
| 4      | Reduce venting/leaks from oil and gas systems  |
| 5      | Heavy-duty vehicle emissions, efficiency improvements <sup>2</sup>   |
| 6      | Cool automobile paints <sup>3</sup>  |
| 7      | Port electrification   |
| 8      | Transportation refrigeration, electric standby   |
| 9      | Truck stop electrification with incentives for truckers  |
| 10     | Tire inflation program   |
| 11     | Require low GWP refrigerants for new MVACs <sup>4</sup>  |
| 12     | Add AC leak tightness test and repair to Smog Check  |
| 13     | Wafflemat system for concrete slab foundations   |
| 14     | Demonstrate use of shoreside generators as bridge to electrical hook-up  |
| 15     | Green ship incentive program   |
| 16     | Anti-idling requirement for cargo handling equipment at ports  |
| 17     | Require the electrification of airport ground support equipment  |
| 18     | Require the electrification of construction equipment at urban sites   |
| 19     | Adopt a regulation and or incentive program to take advantage of emerging hybrid technology for medium duty delivery trucks  |
| 20     | Relatively inexpensive energy savings measures with short pay back times for cement industry   |
| 21     | Explore a greenhouse gas and mercury emission performance standard for cement facilities equivalent to the level achievable through conversion from coal to natural gas  |
| 22     | Relatively inexpensive energy savings measures with short pay back times for fossil fuel power plants built prior to 1980 <sup>5</sup>   |
| 23     | Relatively inexpensive energy savings measures with short pay back times for refineries <sup>6</sup>   |
| 24     | Accelerate the replacement of cargo handling equipment at ports <sup>7</sup>   |
| 25     | Enclose dairy barns to capture methane <sup>8</sup>  |
| 26     | Adopt South Coast and San Joaquin rules on enclosed composting facilities statewide <sup>9</sup>   |
| 27     | Establish necessary rules and or emissions thresholds for transmission to local Air Districts for the phase out, by 2010, of power plants built prior to 1980 that generate over 100 MW of electricity and provide incentives for clean energy production in their place <sup>10</sup> |
| 28     | Prohibit fuel oil burning for base load generation of electricity in facilities 100 MW or greater and built prior 1980 <sup>11</sup>   |
| 29     | We recommend CARB undertake and adopt regulatory measures that require recycling of waste gases at refineries instead of dumping or incinerating them <sup>12</sup>  |
| 30     | Adopt regulatory measures to eliminate the methane exemptions granted to refineries and require methane control measures at refineries <sup>13</sup>   |

|    |   |
|----|---|
| 31 | Identify and implement energy efficiency measures at refineries that include, but are not limited to, conducting an energy audit. This audit shall consider and address, at least:<br>a) Use of clean, renewable energy for refinery electricity consumption<br>b) The impact of heavier crude oil modifications on GHG emission<br>c) Other energy efficiency measures <sup>14</sup> |
| 32 | We recommend CARB undertake and adopt regulatory measures that require recycling of waste gases at oil production sites instead of dumping or incinerating them <sup>15</sup>   |
| 33 | Adopt regulatory measures to eliminate the methane exemptions granted to oil production sites and require methane control measures at oil production sites <sup>16</sup>  |
| 34 | Identify and implement energy efficiency measures that include, but are not limited to, conducting an energy audit at oil production sites. This audit shall consider and address, at least:<br>a) Use of clean, renewable energy for oil production site electricity consumption<br>b) Other energy efficiency measures. <sup>17</sup>   |

**Early Action Measures to be Forwarded by ARB to the CAT Team**

The Committee recommends that all CAT agencies with jurisdiction in the area of energy generation, procurement, siting, permitting, rate-setting and renewable energy deployment in both electricity and transportation sectors, conduct the following:

- 1) Quantify and publicly provide the air emission and cumulative impacts of new power plant construction in CA and report to CARB the implications for the achievement of the state's climate and air quality goals;
- 2) Require proponents of new power plant construction to conduct a thorough and robust renewable energy alternatives assessment. If a more carbon-beneficial combination of energy producing or saving sources is available, then the utility should be required to pursue that avenue. This process should begin with all currently approved and expected power plants;
- 3) Report to CARB on the progress of existing renewable energy deployment programs and identify obstacles to the achievement of the state's renewable energy goals;
- 4) Perform an audit, to be publicly available, of existing and planned low-income rate assistance, energy efficiency, solar, and green building programs and identify barriers that impede local community participation.

**Note: The Committee supports electrification of engines when coupled with efforts to increase use of clean, renewable energy sources such as wind and solar.**

<sup>1</sup> During the development of this measure ARB must identify methods that would eliminate the NOx emissions which result from this technology in order to comply with the prohibition in AB 32 against backsliding on criteria pollutants.

<sup>2</sup> Particularly promising avenues include requiring or incentivizing: Use of wide base tires, Use of automatic tire inflation systems, Use of low viscosity lubricants, Improving freight logistics, and Pursuit of hybrid truck technology. ARB should undertake a complete life cycle analysis before suggesting use of fuel additives.

<sup>3</sup> Any regulation developed would have to ensure that the new paint formulations did not cause backsliding on criteria pollutants.

<sup>4</sup> Any chosen replacements must first undergo a complete life cycle analysis and multi-media toxicity analysis.



# CAPCOA



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07-7-4

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May 14, 2007

Ms. Catherine Witherspoon  
Executive Officer  
California Air Resources Board  
1001 I Street  
P.O. Box 2815  
Sacramento, CA 95812

Re: Proposed Early Action Measures Under AB 32

Dear Ms. Witherspoon,

The California Air Pollution Control Officers Association is writing to support your efforts to identify discrete early action measures to help secure the earliest possible reductions in greenhouse gas emissions, and to urge you to include additional measures and timeframes in your final proposal. We also would like to offer the support and resources of local air districts in developing and implementing early action measures.

Local air districts recognize the critical importance of early reductions to delay the approach of a climate change "tipping point" and to effect a meaningful slowing of the process of climate change. We also recognize the extraordinary resource demands facing the ARB as you implement the requirements of AB 32. We believe that by relying on local air districts for specific tasks, the ARB will be able to reserve crucial resources for those activities that should be developed and implemented centrally.

CAPCOA supports the inclusion of the measures listed in the ARB's April 20, 2007 draft proposal. We believe additional measures can and should be identified as Group 1 measures. We also believe that more specific time frames should be included for measures in Group 2 and Group 3. Most importantly, we believe there are existing processes and programs that can be effectively leveraged for early reductions of greenhouse gases, and we urge you to include specific tasks and milestones for them in your final list of measures.

The local districts understand the difficulties identifying specific measures that can be adopted and implemented in the short time period called for in AB 32. We recommend actions in five key areas that ARB can take to secure these reductions quickly and without investing significant additional resources.

\* **Recommendation 1: Prioritize SIP rulemaking.** CAPCOA recommends that ARB review proposed SIP measures and rank them on the basis of criteria pollutant reductions, public health protection, and greenhouse gas reduction potential. Rules that rank high in all three areas should be given higher priority in the rulemaking calendar. This additional review will not add substantially to workload already planned, but will define GHG reductions that can be achieved in the near term without compromising progress towards clean air or undermining protection of public health.

**Recommendation 2: Review Existing Rules.** CAPCOA recommends that you perform a review of existing state and local rules, similar to an "All Feasible Measures" review that would identify existing rules that, whether expressly intended or not, result in significant reductions of GHGs. Rules that are so identified could be more quickly adapted for statewide implementation and adopted by the ARB. Some local districts have already adopted and implemented regulations intended to reduce GHG emissions; many others have regulations for criteria pollutants which, by virtue of the way the rules are structured, also secure significant collateral GHG reductions. We believe that with a modest investment of resources, perhaps relying on a contractor who could work with a CAPCOA committee, ARB could identify rules with potential for statewide GHG reductions. Because these rules have already been adopted and implemented, much of the preparatory work has been done and the feasibility and costs are well documented; this should shorten both the time and resources needed for state rulemaking. CAPCOA has already begun this review and we look to share initial results with you in the near future.

CAPCOA also recommends that ARB use a focused workgroup process (which you have already discussed with us) to tap district staff resources and expertise with specific source categories to identify discrete early reductions that could be achieved in each category. We believe this process could identify early reduction potential in the six categories ARB has identified for reporting and rulemaking, and could be used to accomplish some of the necessary steps to speed adoption by the ARB. The workgroup process could also be used to build on the review of local regulations (described above) and identify opportunities for additional reductions of greenhouse gases within the existing air pollution program structure. Some local districts have already begun this review and others plan to begin soon. CAPCOA believes such a coordinated workgroup process could identify potential GHG reductions and secure them in the near term through local rule amendments that implement a consistent statewide standard – similar to a suggested control measure. We recommend that this process be included in your final list, and would be happy to work with you in defining an appropriate schedule and associated emission reduction potential.

**Recommendation 3: Minimize Impacts of New Stationary Sources.** CAPCOA recommends that ARB work with the districts to develop a coordinated approach to reviewing greenhouse gas emissions from significant stationary sources in categories that also emit significant amounts of GHGs. As you know, the most environmentally effective and cost effective emission reductions are those implemented before a project is built. The challenge of reaching the 1990 baseline will be easier to meet if we ensure that economic growth occurs along the path of least climate impact. Local air districts already require permits and preconstruction review for such sources, which provides an efficient and effective platform to identify and address GHG emissions from new or modified sources in categories of concern. ARB could establish a general framework for including a review of GHG emissions in the local permitting process. The framework should also identify appropriate local, regional, or global mitigation strategies. This process would be analogous to the development of review programs for toxic air contaminants in the late 1980s and early 1990s. In fact, because of district obligations under CEQA, districts may be required to address GHG emissions associated with new permits regardless of any action by ARB. The outcome would be better coordinated with ARB participation at the outset to identify the scope of the review and the mitigations to be considered.

**Recommendation 4: Leverage CEQA Mitigations.** CAPCOA recommends that ARB work with local districts to coordinate approaches to the review of GHGs under CEQA and capture the reductions that result from mitigation. Local air districts routinely review the impacts of a variety of development projects under CEQA. Local governments are currently contacting air districts with questions about how to incorporate climate change and address GHG emissions of projects, and are seeking specific guidance on GHG significance thresholds for projects. CAPCOA's Climate Protection Committee and Planning Managers Committee are working on this now, and we would like to include ARB staff in this effort. We believe that a focused effort to identify thresholds and mitigation measures could result in practical reductions in the near term through the CEQA process. We recommend that ARB include timelines and commitments to such a process on the early action measures list, and we would be happy to work with you on an appropriate schedule and associated emission reduction potential.

**Recommendation 5: Capture Voluntary Reductions.** CAPCOA recommends ARB work with local districts to establish mechanisms to promote, track, verify, and capture voluntary reductions in GHGs. As you are well aware, there is tremendous interest in voluntary reductions on the part of business, local government, and the general public. CAPCOA believes this interest should be aggressively pursued. Many local air districts are already working with local stakeholders to identify and organize voluntary reduction efforts. CAPCOA also has a Climate Protection Committee that is tasked, among other things, with compiling voluntary reduction strategies and other materials to support individual districts in this area. We suggest ARB work with us to compile information, and that ARB rely on local districts to help form your reporting, verification, and tracking structure for early reduction efforts. We believe ARB should include milestones for implementing this in your final list of measures, and will work with you to identify associated emission reduction targets.

#### Summary

In closing, CAPCOA applauds ARB's efforts to identify and secure early reductions of greenhouse gases under AB 32. We urge you to include additional Group 1 early action measures on your final list, and to establish time frames for the measures in Group 2 and Group 3. We specifically recommend that ARB 1) prioritize SIP reductions to maximize collateral GHG reductions, 2) review existing local rules to identify potential statewide measures or local enhancements, and use district resources in workgroup efforts on specific source categories with significant GHG emissions, 3) coordinate with districts on a strategy to use existing permit programs to review and mitigate greenhouse gases from significant stationary sources, 4) coordinate with districts on review and mitigation of GHGs under CEQA, and 5) rely on local air district resources to implement early reductions through coordinated voluntary programs,

Thank you for your consideration of our recommendations.

Sincerely,



Larry R. Allen  
President



# South Coast Air Quality Management District



21865 Copley Drive, Diamond Bar, CA 91765-4178  
(909) 396-2000 • www.aqmd.gov

May 7, 2007

Via email

Mr. Bart Croes  
Division Chief  
California Air Resources Board  
1001 I Street  
Sacramento CA 95812

Re: Proposed Early Actions to Mitigate Climate Change in California

Dear Mr. Croes:

Thank you for the opportunity to comment on the State's Proposed Early Actions to Mitigate Climate Change in California. This effort will contribute significantly to the overall strategy to reduce greenhouse gases in the state. The following comments are offered for your consideration.

The report includes 3 tables: Table 1, Group 1 – Early Action Measures; Table 2, Group 2 – Additional GHG Reduction Measures Underway or Initiated by ARB in 2007 – 2009 Period; and Table 3, Group 3 – ARB Air Pollution Controls for 2007 – 2009 Adoption with Potential GHG Reductions or Other Climate Co-Benefits. Relative to the measures in Group 1, which will be adopted and implemented by January 1, 2010, SCAQMD staff recommends including a measure to accelerate hybrid penetration, as this technology is already well developed and readily available. At a minimum, this measure should be added to Group 3 if it is not added to Group 1. In addition, the measure on Low Carbon Fuel Standard (1-1) needs to be evaluated in light of the recent Stanford study regarding potential negative implications of E-85.

For Group 2, it would be very helpful for CARB staff to identify years for adoption and implementation for each measure to enable a better sense of priority. Providing preliminary information for potential reductions would also help to understand these measures and their relative benefits. Measure 2-16, Port Electrification should be moved to Group 3 as part of the port measures. There are also several measures that SCAQMD staff would like to see adopted by 2009, not just underway or to be initiated. These are measures 2-9 - Energy Efficiency, 2-13 – Transportation (light-duty vehicle standards), and 2-14 – Transportation (heavy-duty vehicle emission reductions and efficiency improvements).

For Group 3, there are SIP measures in the SCAQMD 2007 Air Quality Management Plan that should be added:

- Evaporative Emission Standards for Recreational Boats and Off-Road Recreational Vehicles; and
- Auxiliary Ship Engine Cold Ironing.

In addition, CARB staff should consider adding one of the SCAQMD measures in the 2007 Air Quality Management Plan – Accelerated Use of Plug-In Hybrids for Light- and Medium-Duty Vehicles, if it is not added to Group 1.

The report also includes tables in Attachment A with the status of assignment to Groups 1, 2, or 3, or deferred to the Scoping Plan. Sixteen of the 24 items in the table are deferred to the Scoping Plan, which is not due for another 18 months. SCAQMD staff recommends that work on these concepts be initiated right away so emission reductions can be realized as soon as possible.

SCAQMD staff also concurs with comments made at the April 30<sup>th</sup> Environmental Justice Advisory Committee meeting that the report could be improved by adding information on the more than 70 proposals received and the reasons why many ideas were not included in this report.

Thank you again for the opportunity to contribute to this important policy document. If you have any questions or would like to discuss this further, please call me at (909) 396-3104 or Elaine Chang at (909) 396-3186.

Sincerely,



Jill Whynot  
Planning and Rules Manager

EC:JW

cc: Alberto Ayala, CARB  
M. Robert, CARB



# South Coast Air Quality Management District



21865 Copley Drive, Diamond Bar, CA 91765-4178  
(909) 396-2000 • www.aqmd.gov

May 9, 2007

*Via email*

Mr. Bart Croes  
Division Chief  
California Air Resources Board  
1001 I Street  
Sacramento CA 95812

Re: Additional SCAQMD Comment - Proposed Early Actions to Mitigate Climate Change in California

Dear Mr. Croes:

South Coast Air Quality Management (SCAQMD) staff sent comments on May 7, 2007 regarding the Proposed Early Actions to Mitigate Climate Change in California. We have an additional comment that CARB staff should consider for inclusion.

An early action measure should be added to require that natural gas supplies for the state be at a Wobbe index of 1360 or lower. As you know, higher carbon content will result in increased carbon dioxide emissions. It is possible to achieve this level by securing natural gas sources with low Btu content, removing heavier hydrocarbon components by a condensing process, injection of inert gas such as nitrogen, and blending high Btu gas with low Btu gas. This would have concurrent nitrogen oxides benefits, as well. Please see control measure #2007CMB-04 in the draft 2007 Air Quality Management Plan for additional information.

Thank you for considering this addition to the early action list. If you have any questions or would like to discuss this further, please call me at (909) 396-3104 or Elaine Chang at (909) 396-3186.

Sincerely,

Jill Whynot  
Planning and Rules Manager

EC:JW

cc: Alberto Ayala, CARB  
M. Robert, CARB

*Cleaning the air that we breathe...*

*Will NOT  
07-7-4*

Suggested Changes to Early Action Measures  
by SCAQMD Staff  
June 21, 2007

Add New Group 1 (Early Action Measures)

- Accelerate hybrid penetration
- Wobbe index  $\leq$  1360 for natural gas

Group 2 Measures (underway or to be started in 2007 – 2009)

- Add specific adoption and implementation dates
- 2-9 Energy Efficiency adopt by 2009
- 2-13 Transportation (LD) adopt by 2009
- 2-14 Transportation (HD) adopt by 2009
- 2-16 Port Electrification adopt by 2009

Add to Group 3 Measures (adopt 2007 – 2009)

- Evaporative Emission Standards for Recreational Boats and Off-Road Recreational Vehicles
- Auxiliary Ship Engine Cold Ironing
- Accelerated Use of Plug-In Hybrids (if not added to Group 1)

Consider Other Measures Suggested by CARB  
Environmental Justice Advisory Group

**APPENDIX B – Staff Evaluation of Stakeholder  
Recommendations / Additional Strategies**

| SUMMARY ID   | STRATEGY TITLE   | PAGE NUMBER |
|--------------|--|-------------|
| Appendix B01 | CAPCOA recommendations   | B- 3        |
| Appendix B02 | Refrigerant tracking, reporting and recovery program   | B- 5        |
| Appendix B03 | Manure digester protocol for calculating greenhouse gas mitigation   | B- 13       |
| Appendix B04 | Reduce methane venting/leaks from oil and gas systems  | B- 15       |
| Appendix B05 | SmartWay truck efficiency  | B- 18       |
| Appendix B06 | Cool paints for automobiles  | B- 22       |
| Appendix B07 | Green ports  | B- 26       |
| Appendix B08 | Transport refrigeration units, electric standby  | B- 31       |
| Appendix B09 | Truck stop electrification with incentives for truckers  | B- 34       |
| Appendix B10 | Tire pressure program  | B- 38       |
| Appendix B11 | Requirement of low-GWP GHGs for new MACS   | B- 41       |
| Appendix B12 | Addition of AC leak test and repair requirements to Smog Check   | B- 45       |
| Appendix B13 | WAFFLEMAT Systems  | B- 48       |
| Appendix B14 | Green ship incentive program   | B- 51       |
| Appendix B15 | Anti-idling requirement for cargo handling equipment at ports  | B- 53       |
| Appendix B16 | Electrification of airport ground support equipment  | B- 55       |
| Appendix B17 | Electrification of construction equipment at urban sites   | B- 58       |
| Appendix B18 | Hybridization of medium and heavy-duty vehicles  | B- 59       |
| Appendix B19 | Cement (A): Energy efficiency of California cement facilities  | B- 65       |
| Appendix B20 | Cement (B): Blended cements  | B- 69       |
| Appendix B21 | Relatively inexpensive energy savings measures with short pay back times for fossil fuel power plants built prior to 1980      | B- 72       |
| Appendix B22 | Identify and implement energy efficiency measures at refiners that include, but are not limited to, conducting an energy audit | B- 76       |
| Appendix B23 | Accelerate the replacement of cargo handling equipment at ports  | B- 78       |
| Appendix B24 | Evaluate enclosed dairy barns as an additional strategy for the capture and combustion of methane emissions at dairies         | B- 80       |
| Appendix B25 | Composting – adopt South Coast and San Joaquin rules statewide   | B- 83       |
| Appendix B26 | Phase out pre-1980 power plants generating at least 100 MW and provide incentives to replace them with clean energy            | B- 85       |
| Appendix B27 | Prohibit fuel oil burning in pre-1980 power plants generating at least 100 MW  | B- 91       |
| Appendix B28 | Refinery methane emissions   | B- 94       |
| Appendix B29 | Specifications for commercial refrigeration  | B- 96       |
| Appendix B30 | Accelerate introduction and deployment of light-duty vehicle (passenger) hybrid technology                                     | B- 101      |
| Appendix B31 | Natural Gas requirement of 1360 Wobbe Index  | B- 103      |
| Appendix B32 | Cool communities program   | B- 106      |
| Appendix B33 | Strengthen light-duty vehicle standards  | B- 110      |
| Appendix B34 | Off Highway Recreational Vehicle (OHRV) evaporative emissions control  | B- 112      |
| Appendix B35 | Determination of evaporative emissions from Pleasure Craft   | B- 114      |
| Appendix B36 | Vessel speed reduction   | B- 116      |
| Appendix B37 | Anti-Idling enforcement  | B- 119      |
| Appendix B38 | SF6 reductions from the non-electric sector  | B- 123      |
| Appendix B39 | Reduction of high GWP GHGs used in consumer products   | B- 126      |
| Appendix B40 | Collaborative research to understand how to reduce GHG emissions from nitrogen land application                                | B- 128      |

# Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

## 1. Early Actions Strategy Name and Proponent

SUMMARY #            *B01*  
ID NUMBER:         *N/A*  
TITLE:                *CAPCOA RECOMMENDATIONS*  
PROPONENT:        *CALIFORNIA AIR POLLUTION CONTROL OFFICERS ASSOCIATION (CAPCOA)*

## 2. Staff Recommendation

Work with CAPCOA to pursue its recommendations. The proposed CAPCOA working group can provide input into the development of the scoping plan for AB 32. Other recommendations could help in quantifying greenhouse gases reductions.

## 3. Action Description

CAPCOA makes five recommendations. These recommendations can support identification and quantification of greenhouse gas reductions as we proceed on AB 32 implementation.

### *PRIORITIZE SIP RULEMAKING*

CAPCOA recommends that ARB's SIP rulemaking be ranked taking into consideration greenhouse gas emissions. The requirements of the federal Clean Air Act dictate that we proceed expeditiously with the measures needed to meet ozone and PM2.5 standards. The most critical near-term SIP rulemakings are already underway and all must be considered top priorities in order to meet federal deadlines. However, as we develop new longer-term SIP measures we will look for opportunities to reduce both criteria pollutants and greenhouse gases.

### *REVIEW EXISTING RULES*

CAPCOA recommends a workgroup process that taps district resources and expertise to identify potential greenhouse gas reductions that could be achieved consistently statewide through local rulemaking. This would be similar to the "suggested control measure" approach that has been used for criteria pollutants. We propose to work with CAPCOA to initiate this process to support development of the AB 32 scoping plan.

### *MINIMIZE GHG IMPACTS OF NEW STATIONARY SOURCES*

CAPCOA recommends that ARB work with local air districts to minimize impacts of new stationary sources. It suggests a coordinated approach to reviewing significant stationary sources in categories that also emit significant amounts of greenhouse gases.

The local permitting process and the environmental review (CEQA) process are suggested as possible mechanisms for achieving GHG emissions mitigation.

Staff suggests a joint effort to identify stationary source technologies for new sources that would reduce both criteria pollutant and greenhouse gases. This could include promoting development of new technologies that achieve multiple benefits.

#### *LEVERAGE CEQA MITIGATIONS AND CAPTURE VOLUNTARY REDUCTIONS*

CAPCOA recommends that ARB work with local air districts on approaches to the review of greenhouse gas impacts under the California Environmental Quality Act (CEQA) process, including GHG significance thresholds for projects, and to develop a process for the capturing of reductions that result from CEQA mitigations.

The Governor's Office of Planning and Research is charged with providing statewide guidance on CEQA implementation. With respect to quantifying any reductions that result from project level mitigation of greenhouse gas emissions, we would like to see air districts take a lead role in tracking such reductions in their regions.

#### **4. Potential Emission Reductions**

To be estimated during scoping plan development or rulemaking process.

#### **5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities**

To be assessed during scoping plan development or rulemaking process.

#### **6. Technical Feasibility**

To be assessed during scoping plan development or rulemaking process.

**8. Division:** Planning and Technical Support Division  
**Staff Lead:** Jeff Weir  
**Section Manager:** Ravi Ramalingam  
**Branch Chief:** Kurt Karperos

#### **9. References:**

*Air Resources Board's Proposed State Strategy for California's 2007 State Implementation Plan, April 26, 2007.*

# Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

## 1. Early Actions Strategy Name and Proponent

SUMMARY #            *B02*  
ID NUMBER:         *NA*  
TITLE:                *REFRIGERANT TRACKING, REPORTING AND RECOVERY PROGRAM*  
                          *(REFRIGERANT RECOVERY FROM DECOMMISSIONED REFRIGERATED SHIPPING CONTAINERS, RESIDENTIAL REFRIGERATION PROGRAM, HIGH-GWP TRACKING/REPORTING/REPAIR/DEPOSIT PROGRAM)*  
PROPONENT:         *STAKEHOLDER SUGGESTION- ENVIRONMENTAL JUSTICE ADVISORY COMMITTEE, ARB STAFF*

## 2. Staff Recommendation

This combination of measures is recommended for addition to the list of early actions. The Board date for consideration of these items is anticipated in 4<sup>th</sup> quarter of 2011. It is presented as one strategy given the interrelated objective, which is to reduce emissions of high-GWP GHGs through establishing requirements for enhanced monitoring, enforcement, reporting, and recovery. It may be determined that more than one strategy is required to effectively address the sources of interest and that the strategy or strategies are likely to include both regulatory and non-regulatory elements.

## 3. Early Action Description

Below is a brief description of potential approaches for addressing each of the source categories considered. Staff will explore the most efficient opportunities for achieving the largest reductions from the below categories which may translate into a single or multiple strategies.

**Refrigerant Recovery from Decommissioned Shipping Containers:** This action consists of an assessment of the magnitude of the emissions from refrigerated shipping containers. Depending on results, the strategy may be similar in scope to the measure aimed at enforcing the federal restrictions on refrigerant venting during servicing or dismantling of motor vehicle air conditioning systems (MVACS). After the recovery from a decommissioned container, it may be desirable to disable the refrigeration unit, which may require a regulation. Enforcement personnel and federal and local air management district assistance would be needed.

**Residential Refrigeration Program:** This involves supporting existing voluntary programs to promote the upgrade of pre-2000 residential refrigeration equipment in need of repair, such as refrigerators and freezers. The program could potentially be expanded to include window unit air conditioners (A/Cs); upgraded HVAC units are not

recommended, as the costs are likely significant and would disproportionately impact lower-income people.

A statewide effort to support programs for expanding the upgrading of old appliances to Energy Star efficiencies or better should be coordinated with various local utilities' voluntary programs and the US EPA's RAD program<sup>1</sup>. Given the utilities lead role in such programs, the ARB's role would be expected to consist of enhancing its outreach efforts to underscore the benefits of participating in such programs. This program could also be coordinated with a foam recovery program, especially if automated recovery of refrigerant, foam, and scrap metal is implemented.

This program will likely result in an increased number of refrigerators entering the waste stream that will need to be properly recycled to achieve GHG emission avoidance. However, if all waste refrigerant, foam, and other materials are properly recycled/destroyed, direct GHG emissions avoidance benefits may be significant, as well as indirect GHG emissions avoidance due to energy efficiency gains<sup>2</sup>.

Part of the residential refrigeration program includes a strategy to be developed in collaboration with the US EPA to enhance the enforcement of end-of-life (EOL) recovery of refrigerant<sup>3</sup>.

Insulation foam contained in residential appliances will be addressed in another strategy, but there may be some overlap between refrigerant and foam recovery for appliances if the entities involved in manual refrigerant removal (which requires US EPA technician certification) are also able/willing to perform manual foam removal on appliances at end-of life (EOL).

The proposed measure will be voluntary, and ARB's role will be to promote replacement through coordination/outreach efforts with the utilities, the US EPA, and the California Energy Commission (CEC), which will enhance public awareness of energy savings and GHG benefits associated with the program.

For maximum effectiveness, this program will also have to be coordinated with ARB's planned end-of-life enforcement and foam recovery measures to ensure that old residential appliances are properly disposed of and high global warming potential (GWP) refrigerants/foams are properly recovered/recycled or destroyed.

**High-GWP Tracking/Reporting/Repair/Deposit Program:** This strategy involves the following: 1) expanding and enforcing the national ban on venting high-GWP GHGs (including fully emissive processes) during equipment/process lifetime; 2) requiring high-

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<sup>1</sup> <http://www.epa.gov/ozone/snap/emissions/radp.html>

<sup>2</sup> Dave Godwin, USEPA, personal communication, 7/06.

<sup>3</sup> The CFC-12 refrigerant/CFC-11 foam blowing agent combination was used for many years in residential refrigerators and freezers, and phaseout of HCFC-141b from appliance foam has only been occurring in the past four years. New refrigerators and freezers generally contain HFC-134a as the refrigerant and HFC-245fa as the foam blowing agent. Currently, ODS recovery is mandated by federal law, and venting HFCs is forbidden, but enforcement is weak and venting is not well-defined. Additionally, EOL technician certification for recovery/reclamation is only required for ODSs and is subject to little oversight/enforcement; the EOL recovery regulation would extend the certification requirement to other high-GWP GHGs and would call for additional oversight/enforcement at transfer stations, landfills, and other disposal facilities.

GWP GHG sales, use and energy use reporting as well as inspection and maintenance (I/M) and leak repair for equipment, cylinders, products, or systems with capacities above some CO<sub>2</sub>E threshold; 3) requiring technician certification for sales, purchase, transport, recovery, reclamation, resale, I/M; and 4) establishing a high-GWP GHG deposit program and/or fines for emissive processes or leaky systems.

Currently, Section 608 of the CAAA limits intentional venting of ODSs and HFCs, requires record keeping for systems employing more than 50 lbs of an ODS, and requires technician certification for ODS systems (I/M, repair, recovery, reclamation). High-GWP GHG sales are only restricted to ODSs in cylinders (not pre-charged equipment); the sales restriction does not apply to HFCs.

Reporting, in addition to record-keeping for ODS systems > 50 lbs, is required in SCAQMD (Rule 1415), and it is proposed that ARB implements a high-GWP GHG reporting requirement rather than record-keeping only. Reporting would be for any high-GWP GHG above a specified CO<sub>2</sub>E threshold (extending beyond ODSs). The permanent reporting protocol could apply to any high-GWP GHG bought, sold, or used, by any manufacturer, retailer, distributor, repair person/technician, auditor, facility/corporate parent. Production plus imports into California (gas in cylinders or as an equipment charge) can be checked against use and exports out of California for mass balance purposes.

High-GWP GHG sales will be restricted to certified technicians (i.e., consumers cannot not buy cans or cylinders of high-GWP GHGs over some threshold value), which differs from current federal law which only limits sales of ODSs to certified technicians (except for ODS refrigerants contained in air conditioners and refrigerators).

The deposit program could apply to cylinders (raw chemical) or pre-charged equipment (such as refrigerators, A/Cs, vending machines, etc.)<sup>4</sup>. Furthermore, fines could be assessed based on annual use reporting and auditing for systems above some CO<sub>2</sub>E threshold. Reporting will have little to no impact on leaking/emissive equipment if there are not financial disincentives in excess of refrigerant costs (i.e., the deposit or fine should cost more than refrigerant needed to recharge a leaky system, so that leaks are promptly fixed).

Deposit/return and/or fine programs would encourage leak-tightness and recovery of high GWP GHGs, as well as encourage upgrading of old, leaky equipment. A similar program has been adopted in Australia, and industry groups are voluntarily considering a deposit/return program in the US.

Adoption of this measure will require a blend of regulatory/non-regulatory approaches, as it will extend current regulations and also require a collaborative effort with the US EPA to enforce what is already established by law.

#### **4. Potential Emission Reductions**

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<sup>4</sup> Consumer goods would be more difficult to subject to deposit and return since they are intended to be fully emissive, but it is believed that purchases over a given CO<sub>2</sub>E limited to certified technicians will inhibit consumers from buying more than small numbers of product.

**Refrigerant Recovery from Decommissioned Shipping Containers:** There is insufficient data on the emissions from this source. For the decommissioned shipping containers, it is estimated that the HFC-134a refrigerant bank at end-of-life could be approximately 15,000 MTCO<sub>2</sub>E per year in the area surrounding the Ports of Long Beach and Los Angeles. This is based on the estimated Los Angeles-Long Beach fraction of world shipping container activity of approximately 8 percent and 30 percent of the total container population consists of refrigerated shipping containers. The percent of refrigerated containers that a ship may carry varies between 10 to 50 percent of the total container capacity. The estimated Los Angeles-Long Beach fraction of world refrigerated shipping container activity applied to the estimated annual turnover rate of refrigerated shipping containers has been estimated to be 100,000. The refrigerant charge in modern shipping containers ranges from 13 to 16 pounds. If these containers are allowed to accumulate, the bank could become on the order of 0.1 MMTCO<sub>2</sub>E in a 5 to 10 year period assuming a 10 pound refrigerant charge at decommissioning. Thus, the reduction potential of a mitigation strategy for this source would be less than 0.1 MMTCO<sub>2</sub>E in 2020. In addition, given that these shipping containers may last from 20 to 30 years, there may be a significant number of older CFC-based systems. Finally, it is important to determine what happens to the shipping containers as they approach end-of-life.

**Residential Refrigeration Program:** Estimated annual emission reductions of 0.8 MMTCO<sub>2</sub>E are possible for refrigerant recovery<sup>5</sup>. Of the 0.8 MMTCO<sub>2</sub>E of annual emissions avoided for refrigerant recovery, about 0.7 is due to recovery of R-12 refrigerant. This estimate does not include the benefits from deploying more efficient systems sooner (see energy efficiency calculations, below).

Although refrigerant recovery is currently supposed to occur at the time of disposal, destruction of refrigerant is not required, and it is generally assumed that recovered/reused refrigerant will eventually be emitted.

The CO<sub>2</sub>E emissions avoidance was calculated for 2005, and only refrigerators and freezers going to landfills were considered; numbers of pre-2000 appliances in need of repair were not available. Inclusion of portable A/C units could increase emissions benefits, but numbers of portable units that are repaired or landfilled each year are unknown. Without knowledge of the numbers and age distributions of appliances in California, 2020 emissions reductions based on sector growth and transitional refrigerant/blowing agent use estimates were not possible. However, it is reasonable to assume that approximately 0.8 MMTCO<sub>2</sub>E reductions will be possible every year until refrigerators and freezers containing R-12 are gone, which will happen in large part by 2020.

Energy efficiency emissions avoidance in 2020 resulting from appliance retirement could not be calculated due to lack of data regarding age distribution of California appliances,

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<sup>5</sup> The following assumptions were used: 1) 20 year lifetimes for refrigerators, 2) R-12 use in refrigerators stopped in 1995; from 1995 – 2005 HFC-134a was used, 3) in 2005, half of disposed refrigerators contain R-12 as the refrigerant and the other half contain HFC-134a as the refrigerant, 4) 13,000,000 refrigerator/freezers are disposed of annually in the US and 60% go to landfills or transfer stations, 5) the California population fraction was roughly 13% in 2005, 6) 100-year direct GWPs of 8100 and 1300 were used for R-12 and HFC-134a, respectively, 7) refrigerant masses of 0.23 kg/appliance and 0.16 kg/appliance for R-12 and HFC-134a, respectively, were obtained from USEPA (Dave Godwin, personal conversation, 2/07).

but again it is reasonable to assume that an additional 0.45 MMTCO<sub>2</sub> reduction is possible annually<sup>6</sup>.

To summarize, by 2020, annual emission reductions of roughly 1.25 MMTCO<sub>2</sub>E are possible by recovering refrigerant from pre-2000 refrigerators and freezers, and by requiring upgrading to Energy Star or better appliances.

**High-GWP Tracking/Reporting/Repair/Deposit Program:** Staff believes that significant emission reductions may be realized through the proposed strategy; however, emission reductions cannot be estimated for this strategy, as there are no data to support emission avoidance calculations.

**Total Reductions:** The combined annual reductions possible with this group of strategies is 1.25 MMTCO<sub>2</sub>E, which is a lower-bound estimate that does not include CFC-containing shipping containers, appliances that are upgraded rather than repaired, and the impacts of requiring reporting/repair/deposits for systems over a given CO<sub>2</sub>E threshold.

## 5. Estimated Costs/Economic Impacts and the Impacted Sectors/Entities

**Refrigerant Recovery from Decommissioned Shipping Containers:** Very little specific information on costs and economic impacts is known today. Per the federal regulation (40 CFR 82), refrigerant cannot be released to the atmosphere. Specialized equipment and certified technicians are required to properly carry out this measure. Equipment to recover the refrigerant may cost \$5,000. The training cost for servicing certification is minimal. Both the equipment and the certified technicians are something that businesses should already have if they are in compliance with the existing federal regulation. It is possible that existing businesses in the air conditioning and refrigeration servicing industry may be able to handle recovering the refrigerant from the decommissioned refrigerated shipping containers. There will also be a requirement to remove or disable the decommissioned refrigeration unit, which should be a minimal cost. It is believed that as these shipping containers age, they get sold to smaller shipping businesses and these may bear the brunt of the measure for decommissioned containers. In addition, some of these units may be sold to restaurants and other businesses for increased refrigeration capacity. If the federal regulation is applied to in-use containers, then all segments of the business would be affected.

**Residential Refrigeration Program:** The US EPA states that because of reduced energy demand, appliance incentive/disposal programs cost about \$0.04 on average to reduce each kWh of demand. This translates into about \$63/MTCO<sub>2</sub>, which includes the incentives and credits given to upgrade older appliances<sup>7</sup>.

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<sup>6</sup> USEPA estimates that 700 kWh/year savings are possible by replacement of a 20 yr old refrigerator with a current energy star appliance; an emission factor of approximately 1.4 lbs CO<sub>2</sub>/kWh for gas-generated electricity was obtained from Carbon Dioxide Emissions from the Generation of Electric Power in the United States, DOE, 7/2000: <http://tonto.eia.doe.gov/FTP/ROOT/environment/co2emiss00.pdf>

<sup>7</sup> See above footnote.

The impacted sectors and entities would mostly be appliance salvagers/recyclers and individuals disposing pre-2000 appliances; however, with incentives and rebates, the cost associated with disposal and some of the cost of a new appliance is avoided.

The US EPA RAD program was started in 2006 and the success of the program has not been gauged yet, although it is anticipated that a mandatory program would be more effective.

**High-GWP Tracking/Reporting/Repair/Deposit Program:** Record-keeping, I/M and repair is already required for systems containing > 50 lbs of an ODS refrigerant; in SCAQMD, reporting is required for these systems in addition to record-keeping. Even those entities who are not yet keeping records for reporting purposes must still have some records of refrigerant/product purchases for resale and income tax purposes. Therefore, the costs associated with record-keeping and reporting are believed to be negligible.

I/M costs are not believed to be significant<sup>8</sup>, but leak repair and/or high GWP GHG recovery for some processes may be expensive. The costs associated with I/M and leak repair cannot be estimated due to the large variety in numbers and types of equipment covered by this strategy. Costs associated with a deposit and return program are unknown, but will presumably be passed on to the consumer at the time of purchase.

## 6. Technical Feasibility

The technology required to remove refrigerants from shipping containers and appliances is feasible and commercially available. Automated refrigerant and foam removal from appliances is also technically feasible, and can be performed during scrap metal processing and recovery<sup>9</sup>.

There are no anticipated technical feasibility issues for the tracking/reporting/repair/deposit program other than recovery of high-GWP GHGs for certain unknown, emissive processes.

## 7. Additional Considerations

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<sup>8</sup> Presently, owners or operators of large RAC systems should maintain and repair their systems for optimal performance and reduced energy costs, so the incremental cost of the new rule is not expected to be significantly higher than current costs, unless leaks are going undetected and unrepaired. The costs to pay for yearly inspection and maintenance by certified technicians is not expected to be more than about \$200 (based on one 8-hour workday by a HVAC technician at a rate of \$22/hour in California:

[http://www.payscale.com/research/US/Job=HVAC\\_Service\\_Technician/Hourly\\_Rate/by\\_State](http://www.payscale.com/research/US/Job=HVAC_Service_Technician/Hourly_Rate/by_State)).

The incremental costs per system associated with an owner, operator, or HVAC technician/auditor filling out several short reporting forms is also expected to be less than \$200 (see above).

<sup>9</sup>Guidance on the Recovery and Disposal of Controlled Substances Contained in Refrigerators and Freezers, SEPA, 2002:

[http://www.sepa.org.uk/pdf/consultation/closed/2003/fridge/fridge\\_consultation.pdf](http://www.sepa.org.uk/pdf/consultation/closed/2003/fridge/fridge_consultation.pdf)

**All Strategies:** Ozone depleting substances (ODSs) were used in the past as refrigerants and foam-blowing agents; each of the strategies described above include ODSs as they exist in older refrigeration systems, appliances, and foams. Recovering and destroying ODSs from containers and appliances is a cost-effective way to reduce high-GWP gas emissions, and also reduces negative impacts on stratospheric ozone.

An enforcement component for the decommissioned container and tracking/reporting/repair/deposit measures is anticipated, since these are regulatory measures rather than voluntary measures.

**Refrigerant Recovery from Shipping Containers:** Staff will perform a needs assessment to improve the current understanding of overall refrigerant leakage emissions and refrigerant banks for both active and decommissioned refrigerated shipping containers. This is particularly important for the major port areas of Los Angeles, Long Beach, and Oakland. If mitigation action is supported by the analysis, the measure should involve a program enforcing the existing provisions of the existing federal regulation, 40 CFR 82. A basic inventory is needed to determine the extent that refrigerant emissions are unaccounted for. In addition, end-of-life accounting for these different types of refrigerated containers needs to be explored.

**Residential Refrigeration Program:** The impacted sectors and entities would mostly be appliance salvagers/recyclers and possibly individuals disposing of foam-containing appliances, as recovery costs are expected to be passed along to the user.

California trade associations associated with Certified Appliance Recyclers and recyclers of scrap metals are unknown.

Coordination with the US EPA with respect to this regulation is ongoing. Further coordination with utilities participating in appliance trade-in programs is anticipated.

**High-GWP Tracking/Reporting/Repair/Deposit Program:** The affected entities will be owners/operators/purchasers/sellers of high-GWP GHGs and systems containing those chemicals, as well as contractors/technicians who install/repair such systems.

A partial list of trade associations possibly impacted, either positively or negatively, by the regulation follows: ARAP (described previously), the Air-Conditioning and Refrigeration Institute (ARI), American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), North American Technician Excellence (NATE), and many others unknown to staff (equipment trade associations, building trade associations, industrial chemical and consumer trade groups, semiconductor and other industrial process trade groups, etc.).

Coordination with the US EPA and SCAQMD with respect to this strategy would be ongoing.

- 8. Division:** Research Division  
**Staff Lead:** Whitney Leeman/Winston Potts  
**Section Manager:** Michael Robert/Tao Huai  
**Branch Chief:** Vacant/Alberto Ayala

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USEPA, *Draft Proposed Measures Arising from the IPCC/TEAP Special Report & its Supplement, by End-Use, Expert Workshop on IPCC/TEAP Special Report, July 2006.*

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# Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

## 1. Early Actions Strategy Name and Proponent

SUMMARY #            *B03*  
ID NUMBER:         *ARB 2-1 / EJAC-2*  
TITLE:                *MANURE DIGESTER PROTOCOL FOR CALCULATING  
GREENHOUSE GAS MITIGATION*  
PROPONENT:        *ENVIRONMENTAL JUSTICE ADVISORY COMMITTEE*

## 2. Staff Recommendation

This measure was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, no change in the classification of this measure is recommended. The Board date for consideration of this item is anticipated in 3<sup>rd</sup> quarter of 2008.

Specifically, staff recommends Board endorsement of the California Climate Action Registry (CCAR) manure digester protocol in order to promote voluntary greenhouse gas emissions reductions.

## 3. Early Action Description

Description of Protocol – The manure digester protocol provides methodologies for calculating reductions in the emissions of greenhouse gases resulting from the installation of a manure digester at an animal agricultural facility.

Technology Description – Manure digesters (also called biogas control systems) are systems which trap gaseous emissions from manure (primarily methane) and combust the gas. The trapping process is achieved by enclosing the manure, which often involves covering a manure lagoon with plastic or otherwise isolating the manure from the ambient environment. The combustion process occurs either by combusting the trapped methane biogas in an engine in order to generate electricity, or by venting and flaring the gases.

CCAR Protocol Development Process – CCAR began developing a protocol for calculating manure greenhouse gas emission back in April 2006. The protocol development process began with a first scoping meeting, included multiple working group meetings and document reviews, and included representatives from nearly every stakeholder group, including industry, government, academia, and the general public.

Need for Digester Protocol Endorsement – Although this protocol was adopted by CCAR, endorsement by the Board would send a clear signal that the ARB considers the protocols to be accurate and acceptable for voluntary GHG emissions reductions. To achieve this end, the ARB is initiating a process to continue discussions on the protocol by holding workshops to solicit comments on the protocol and to identify potential improvements. The ultimate goal is to present the protocol to our Board for endorsement as a voluntary greenhouse gas reduction measure.

Establishing a voluntary protocol can help incentivize the installation of manure digesters by legitimizing the technology and offering a pathway to quantify and verify the greenhouse gas benefits. Keeping this protocol a voluntary measure helps avoid premature technology mandates which could have significant cost and environmental drawbacks due to digesters currently being a costly, combustion-oriented technology.

#### **4. Potential Emission Reductions**

Digesters have the potential to provide a 50 percent reduction in GHG emissions resulting from manure storage (0.006 MMT CO<sub>2</sub>E per digester) as well provide electrical energy, offsetting the production of additional GHGs.

#### **5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities**

Cost per digester can range from the low hundreds of thousands of dollars to over a million dollars, depending on the digester type (covered lagoon, plug flow, etc.) and the amount of manure and biogas being processed. The captured biogas can be valuable if used for heating (water, animal housing) or combusted in an engine/ generator to produce electricity. Thus, the digester can reduce farm costs and may provide income if the gas or electricity is sold to other entities or back to the grid.

#### **6. Technical Feasibility**

Manure digesters are currently installed and operating at a limited number of farms in California.

#### **7. Additional Considerations**

**Affected Entities:** Farmers, energy companies, and any companies involved in the business of mitigating greenhouse gases (AgCert, CEERT, etc.)

**Trade Associations:** California Farm Bureau, Western United Dairymen, California Dairy Campaign.

**Government Agencies Coordination:** State Water Resources Control Board, local Air Pollution Control Districts, California Department of Food and Agriculture, California Climate Action Registry and others.

**Proposed Board Hearing Date: September 2008**

|                         |   |
|-------------------------|---|
| <b>8. Division:</b>     | Planning and Technical Support Division |
| <b>Staff Lead:</b>      | Kevin Eslinger                          |
| <b>Section Manager:</b> | Dale Shimp                              |
| <b>Branch Chief:</b>    | Richard Bode                            |

# Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

## 1. Early Actions Strategy Name and Proponent

SUMMARY #            *B04*  
ID NUMBER:         *EJAC-3/ARB 2-12*  
TITLE :                *REDUCE METHANE VENTING/LEAKS FROM OIL AND GAS SYSTEMS*  
PROPONENT:        *ENVIRONMENTAL JUSTICE ADVISORY COMMITTEE AND CALIFORNIA AIR POLLUTION CONTROL OFFICERS ASSOCIATION*

## 2. Staff Recommendation

This measure was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, no change in the classification of this measure is recommended. The Board date for consideration of this item is anticipated in 4<sup>th</sup> quarter of 2010.

Staff recommends an evaluation of the effectiveness of the existing district rules. Most likely these rules can be amended and readily adopted by the ARB for statewide implementation. Staff also proposes to investigate the feasibility of deploying innovative technologies and to improve management practices, including the stakeholder's proposal to implement energy efficiency measures that will further promote recycling of otherwise vented gases. These combined actions could potentially reduce methane emissions from both gas and oil systems by approximately 1.0 MMTCO<sub>2</sub>E in 2020<sup>1</sup>.

## 3. Early Action Description

Emissions from natural gas systems are primarily methane gas. There are four major sources of methane emissions from the systems: production, processing, transmission, and distribution of natural gas. These emissions are process related, mostly stemming from normal operations, routine maintenance, and system upsets. Also, a relatively smaller amount of methane emissions results from oil systems.

Several air districts have adopted and implemented rules to reduce volatile organic compound (VOC) emissions from natural gas and crude oil production and processing facilities. These existing rules may also reduce methane emissions. In addition, there are several proven cost-effective technologies and management practices that would result in a significant reduction of methane emissions.

Staff will take the following approach to achieve the GHG reduction goal from oil and gas systems as stated in the 2006 CAT report:

- Amend existing rules<sup>2,3</sup>  
Form a working group that consists of ARB, district, and interested stakeholders to review the existing rules to identify potential methane emissions reduction measures.

- Improve management practices<sup>4</sup>  
Encourage districts with oil and gas systems under their jurisdiction to practice directed and more frequent inspections of compressor stations, gate stations, surface and storage facilities, transmission pipelines, and off-shore platforms.
- Require the installation of cost-effective technologies<sup>4</sup>  
Numerous technologies have been identified and proven in the U.S. EPA Natural Gas STAR program<sup>5</sup>, a voluntary program partnership with the oil and natural gas industries, that will pay back investments in a short period of time through saleable gas savings. These technologies include replacement of high- with low-bleed pneumatic devices, installation of a flash tank on glycol dehydrators, retrofitting compressors to capture vented gas, and using an infrared aerial imaging camera to detect leaks, etc.

#### **4. Potential Emission Reductions**

Among the above identified strategies, staff estimated installation of new technologies will provide the greatest potential GHG emissions reduction, about 70 percent of the targeted goal of 1.0 MMTCO<sub>2</sub>E in 2020, while the rest will come from the existing rule amendments (~10 percent) and enforcement (~20 percent). Collectively, these strategies will provide a medium potential of GHG emissions reduction. They will also provide further emissions reduction of VOCs and toxics, with no incurred fuel penalty.

#### **5. Estimated Costs / Economic Impacts and the Impacted Sectors/ Entities**

ARB will develop this measure in partnership with CAPCOA. ARB will need additional resources to develop and enforce the new rule. CAPCOA may also require additional resources for complementary rulemaking to ensure that the rules are consistent.

As for the oil and gas industries, investment in new technologies will likely pay for itself through net fuel savings to offset the costs. As a result, staff believes that none of the proposed strategies will cause any potential disproportionate economic impacts on small businesses or environmental justice communities from increased utility rates.

#### **6. Technical Feasibility**

Natural Gas STAR partner companies have implemented most of the new technologies identified through a voluntary program established by the U.S. EPA when the natural gas prices were relatively low. These technologies were proven to be reliable and cost-effective. With the higher gas prices today, these technologies are even more cost-effective and attractive to the industry.

#### **7. Additional Considerations**

Staff has reviewed several districts' rules, addressing VOC emissions, that may have reduced methane emissions, and will work together with the districts to identify if any oil and gas industries have implemented fuel saving technologies. The ARB has legal

authority to develop regulations and outreach programs to speed up the deployment of these technologies. However, staff believes a comprehensive and uniform regulation for this CAT strategy cannot be achieved in 18 months.

**Affected Entities:**

Oil and gas industries, pipeline operators, gas processing and storage facilities, utility companies

**Trade Associations:**

American Gas Association (AGA), Gas Processors Association (GPA), Interstate Natural Gas Association of America (INGAA), Kinder Morgan, Natural Gas Supply Association (NGSA), Pacific Gas and Electric Company (PG&E), Southern California Gas Company (SoCalGas), San Diego Gas & Electric (SDG&E), Western States Petroleum Association (WSPA)

**Government Agencies to coordinate with:**

Air Districts, California Air Pollution Control Officers Association (CAPCOA), California Energy Commission (CEC), California Public Utility Commission (CPUC), California State Land Commission (CSLC), Federal Energy Regulatory Commission (FERC), United States Environmental Protection Agency (U.S. EPA)

**8. Division:** Stationary Source Division  
**Staff Lead:** Win Setiawan  
**Section Manager:** Terrel Ferreira  
**Branch Chief:** Barbara Fry

**9. References:**

<sup>1</sup>*California Climate Leadership: Strategies to Reduce Global Warming Emissions*  
July 2005, Tellus Institute.

<sup>2</sup>Stakeholders' comments to the ARB Proposed Early Action Measures to Reduce Greenhouse Gases, June 2007 Board Hearing, Los Angeles:

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<sup>3</sup>*Various Air Districts Rules.*

<sup>4</sup>*U.S. Methane Emissions 1990-2020: Inventories, Projections, and Opportunities for Reductions*, EPA 430-R-99-013, September 1999, U.S. EPA.

<sup>5</sup>*The EPA Natural Gas STAR Program:*

<http://www.epa.gov/gasstar/>

# Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

## 1. Early Actions Strategy Name and Proponent

SUMMARY #            *B05*  
ID NUMBER:         *EJAC-4/ARB 2-14*  
TITLE:                *SMARTWAY TRUCK EFFICIENCY*  
PROPONENT:        *2006 CAT REPORT AND STAKEHOLDER SUGGESTION*

## 2. Staff Recommendation

This measure was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, it is recommended that this measure be reclassified as a discrete early action. The Board date for consideration of this item is anticipated in 4<sup>th</sup> quarter of 2008.

The rationale for staff's recommendation is based on the commercial availability of a wide variety of technologies that improve fuel efficiency of heavy-duty vehicles that pay for themselves from fuel savings in a very short time. Although these technologies are commercially available, the trucking industry has been reluctant in using them due to the high initial capital investment and logistic issues related to using some of the technology at loading docks and other locations. However, staff believes these issues can be resolved. Therefore, staff recommends developing a regulatory program and evaluate whether financial assistance would be needed to help small businesses comply with the proposed regulation.

## 3. Early Action Description

The strategy would require existing trucks/trailers to be retrofitted with the best available fuel efficiency "SmartWay Transport"<sup>1</sup> and/or ARB approved technology. Technologies that improve fuel efficiency of trucks may include devices that reduce aerodynamic drag and rolling resistance. Aerodynamic drag may be reduced using devices such as cab roof fairings, cab side gap fairings, cab side skirts, and on the trailer side, trailer side skirts, gap fairings, and trailer tail. Rolling resistance may be reduced using single wide tires or low-rolling resistance tires and automatic tire inflation systems on both the tractor and the trailer.

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<sup>1</sup> The United States Environmental Protection Agency (U.S. EPA) in collaboration with the freight industry has developed a voluntary program designed to increase energy efficiency while significantly reducing greenhouse gases and criteria pollutants. The program, known as the SmartWay Transport Partnership (SmartWay Transport), encourages trucking companies to use technologies that improve fuel economy and reduce emissions. The SmartWay Transport also designates highly fuel efficient and emission reduction technology packages as SmartWay Upgrade Kits which can be purchased at various SmartWay partner centers, dealerships, and service centers. (<http://www.epa.gov/otaq/smartway/documents/420f07027.htm>)

The requirements would apply to California and out-of-state registered Class 8 trucks (gross vehicle weight rating greater than 33,000 pounds) that travel to California. Most of the newer Class 8 combination trucks are long haul trucks for which technologies that reduce both aerodynamic drag and rolling resistance would be appropriate. The older model combination trucks are typically considered short haul trucks and thus spend considerably less time at highway speeds, reducing significantly any benefits associated with aerodynamic improvements since drag varies with the square of the vehicle speed. Thus, it would be most appropriate to require only rolling resistance improvements for these trucks. Straight trucks (trucks with an integrated cargo area) would likely be required to be equipped with devices that reduce aerodynamic drag as well as rolling resistance.

Staff's preliminary thinking is that the rule could be implemented through a phase-in schedule with 10 percent of the trucks and trailers meeting the requirements in 2010, 25 percent in 2011, 60 percent in 2012, and 100 percent in 2013. This rule should also require that new 2010 and subsequent trucks and trailers that are sold in or service California be "SmartWay" certified tractors and trailers<sup>2</sup>.

Although the cost of retrofitting the trucks and trailers would eventually be recovered through fuel savings, the upfront investment capital needed to comply with the requirements may become a financial burden to businesses, especially small businesses and those that own multiple trailers per tractor. Therefore, staff recommends that an evaluation be conducted to determine whether a financial assistance program would be needed to help small businesses comply with the requirements.

#### **4. Potential Emission Reductions**

Potential GHG emission reductions were estimated for calendar years 2010 and 2020. For 2010, the scenario assumes that 10 percent of the existing 2009 and older model year (MY) trucks and tractor-trailer combinations and all 2010 MY trucks and tractor trailer combinations comply with the requirements. MYs 2006 to 2010 trucks were assumed to be long haul, MYs 2000 to 2005 medium haul, and MYs 1990 to 1999 short haul. Based on these assumptions and considering the total vehicle miles traveled both inside and outside of California, in 2010, the estimated GHG reductions could be up to 6 MMTCO<sub>2</sub>E of which about 7% would occur within California. Similarly in 2020, MYs 2016 to 2020 were assumed to be long haul, MYs 2010 to 2015 medium haul and MYs 2000 to 2009 as short haul trucks. Thus, the 2020 estimated GHG reductions could be up to 20 MMTCO<sub>2</sub>E of which about 11% would occur within California. Requiring compliance by California registered trucks and trailers would significantly reduce the

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<sup>2</sup> U.S. EPA Certified SmartWay tractors and trailers are long haul tractors and trailers equipped with components that significantly reduce fuel consumption and emissions. The specifications for a U.S. EPA Certified SmartWay tractor include a model year 2007 and later engine, integrated cab-high roof fairings, cab side fairing gap reducers, tractor fuel-tank side fairings, aerodynamic bumper and mirrors, options for reducing extended engine idling, and options for low-rolling resistance tires. The specifications for a U.S. EPA Certified SmartWay trailer are side skirts, weight-saving technologies, gap reducers on the front of the trailer or trailer tail, and options for low resistance tires. For further information refer to: <http://www.epa.gov/smartway/documents/420f07033.htm> .

GHG benefits of this rule to 0.2 and 1.3 MMT CO<sub>2</sub>e in 2010 and 2020, respectively. The strategy is also expected to reduce emissions of criteria pollutants and especially emissions of oxides of nitrogen (NO<sub>x</sub>) since NO<sub>x</sub> is directly related to the tractive power requirements. Staff has not yet precisely quantified the reductions in emissions of criteria pollutants that may result from this strategy, but expect them to be on the order of 10 percent reduction for pollutants such as NO<sub>x</sub>, which are closely related to fuel use.

## **5. Estimated Costs/ Economic Impacts and the Impacted Sectors / Entities**

Entities that may be affected by this strategy include the freight industry, trailer manufacturers, truck manufacturers, tire manufactures, businesses that own trailers to haul their freight into and out of California, and cab and trailer aerodynamic device manufacturers. The strategy is expected to provide cost savings to trucking businesses over the useful life of the tractor trailer combination by reducing fuel consumption. Assuming that add-on devices result in 13.9 percent fuel economy gain, the savings are approximately \$5,400 per year for a truck with a baseline fuel economy of 6.1 miles per gallon and an average mileage accrual rate of approximately 90,000 miles per year, and a fuel cost of \$3.00 per gallon. The cost of the add-on devices for a tractor trailer combination, which staff estimates to be approximately \$12,000<sup>3</sup>, can therefore be recovered within 2 to 2.5 years for a trailer-to-tractor-ratio of 1 and within 8 to 10 years for a trailer-to-tractor ratio of three<sup>4</sup>. Businesses that own only trailers and no tractors may not be able to recover the cost of retrofitting their trailers through fuel savings, and therefore, they may need to recover their investment either by paying less to haulers or by passing it to customers by increasing the cost of their merchandise.

## **6. Technical Feasibility**

As indicated above, technologies that improve fuel economy of trucks are currently commercially available. Most of the tractors currently on the road are equipped with cab roof fairings and cab side fairing gap reducers. Trailer side skirts, trailer side fairing gap reducers, single wide tires and automatic tire inflation systems are also commercially available as SmartWay Upgrade Kits. However, there are some minor technical issues with these technologies that will need to be resolved. Retrofit of cab aerodynamics may or may not be possible depending on whether the tractor has factory installed reinforcements or not. Trailer side skirts may be problematic on some trailers where the side skirt interferes with access to equipment. Also, some fleets have expressed concern on trailer side skirts getting damaged when driving over road dips or bumps. The use of trailer tails is currently very limited due to functionality problems at loading docks. Currently, manufacturers of SmartWay devices are working on solutions to these problems and staff believes that these minor technical problems will be resolved by the time the rule is implemented or can be addressed in the development of this rule.

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<sup>3</sup> The \$12,000 estimate includes the cost for trailer aerodynamics (side skirts, gap fairings, and trailer tail), single wide tires and wheels for the tractor and trailer, automatic tire inflation system, and installation cost.

<sup>4</sup> The industry average trailer-to-tractor ratio is not exactly known. However, the most commonly cited numbers range between 2 to 3 trailers-per-tractor. The higher the number of trailers per tractor, the longer it takes to recover the cost from fuel savings.

## 7. Additional Considerations

This regulatory strategy is motivated primarily by its potential to reduce GHGs. All portions of this strategy can be accomplished under the authority granted by the California Global Warming Solutions Act of 2006, Assembly Bill 32 (AB 32). AB 32 provides the Air Resources Board (Board) with the authority to regulate sources of GHGs to achieve the maximum and cost-effective GHG emission reductions from these sources. The item can be taken to the Board by the 4<sup>th</sup> quarter of 2008 but requires additional resources.

Affected Entities: Truck carriers, shipper carriers, trailer manufacturers, truck manufactures, truck and trailer aerodynamic device manufacturers, tire manufacturers, businesses that own trailers to haul their freight into and out of California

Trade Associations: American Trucking Association, California Trucking Association, Truck Manufacturers Association, Truck Trailer Manufacturers Association, California Chamber of Commerce.

Government Agencies to coordinate with: None.

**8. Division:** Mobile Source Control Division  
**Staff Lead:** Daniel Hawelti  
**Section Manager:** Stephan Lemieux  
**Branch Chief:** Michael Carter

# Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

## 1. Early Actions Strategy Name and Proponent

SUMMARY #            *B06*  
ID NUMBER:         *EA 2-15*  
TITLE:                *COOL PAINTS FOR AUTOMOBILES*  
PROONENT:         *EARLY ACTION REPORT OF APRIL 21, 2007 AND  
STAKEHOLDER SUGGESTION*

## 2. Staff Recommendation

This measure was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff no change in the classification of this measure is recommended. The Board date for consideration of this item is anticipated in 2<sup>nd</sup> quarter of 2009.

## 3. Early Action Description

Cool paints are highly solar energy reflective coatings formulated with pigments that have low absorption (high reflectance) of sunlight. White is considered to reflect more sunlight than any other color. But while white paints reflect the visible light, they may or may not reflect the balance of the sunlight. The majority of solar energy is not in the visible range, therefore careful formulation of pigments can allow the reflectance of near-infrared (NIR) sunlight which contains about 52 percent of the solar energy, while maintaining visible light reflectance (i.e., perceived color). For vehicles, the more solar energy is reflected, the less the vehicle's interior will heat up when it is parked in the sun.

Cool paints have been demonstrated by the Society of Automotive Engineers as part of the Improved Mobile Air Conditioning Cooperative Research Program. They are technically feasible in the near-term for new vehicles. Researchers at Lawrence Berkeley National Laboratory (LBNL) tested various automotive paints formulated for use between 1992 and 2002<sup>1</sup>. Using a solar spectrometer, they determined the reflectance of both visible and NIR light wavelengths. Table 1 presents the reflectance of light (higher reflectance equals cooler paint). As expected, the dark colors tended to reflect less light; more light energy is absorbed. The potential of cool paints can be readily seen when examining the results for red paints, shown in **bold** on the table. The red paints ranged from a reflectance of 0.13, not much better than the black paint tested, to a high of 0.37. While that does not approach the 0.70 seen for the white vehicle, it is nearly three times more reflective than the worst performing red paint.

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<sup>1</sup> These paints were all tested with a white primer.

Table 1. Reflectance of Vehicle Paints

| Vehicle Paint Color                    | Visible light | NIR  | Total       |
|--|---------------|------|-------------|
| Black, 1998 Ford                       | 0.04          | 0.04 | 0.04        |
| Dark Grey, 1998 Dodge Intrepid         | 0.06          | 0.05 | 0.06        |
| Grey Metallic, 1992 GM Buick           | 0.21          | 0.25 | 0.22        |
| Silver, 1992 Ford Escort               | 0.49          | 0.54 | 0.50        |
| Gold Metallic, 1998 Ford Taurus        | 0.46          | 0.56 | 0.49        |
| Light Blue Metallic, 1994 Honda Accord | 0.33          | 0.44 | 0.39        |
| Blue Metallic, 2001 GM                 | 0.06          | 0.13 | 0.10        |
| Green, 1995 Chevy Camero               | 0.07          | 0.08 | 0.08        |
| <b>Red, Chevy</b>                      | 0.08          | 0.18 | <b>0.13</b> |
| <b>Red, 2000 Ford Escort</b>           | 0.14          | 0.50 | <b>0.33</b> |
| <b>Red, 2002 Chevy Avalanche</b>       | 0.15          | 0.35 | <b>0.25</b> |
| <b>Red, 1993 Chevy S10 Blazer</b>      | 0.15          | 0.57 | <b>0.37</b> |
| White, 1997 GM Park Avenue             | 0.70          | 0.77 | 0.70        |

#### 4. Potential Emission Reductions

The concept behind this proposed action item is that the use of cool paints would reduce the solar heat gain in a vehicle parked in the sun. A cooler interior would provide drivers with less need to activate the air conditioner (A/C).

LBNL researchers have investigated the CO<sub>2</sub> reduction that would result from a 5°F reduction in vehicle temperature at start up.<sup>2</sup> LBNL's Dr. Hashem Akbari estimates that such a reduction in temperatures, applied to the light duty vehicle fleet in California, would reduce CO<sub>2</sub> emissions from A/C use by about 25 percent, reducing current CO<sub>2</sub> estimates of A/C related emissions of 10.2 million metric tons per year (MT/yr) to 7.8 MT/yr, a 2.4 MT/yr reduction.<sup>3</sup>

Staff also requested input from Dr. John Rugh, National Renewable Energy Laboratory, on the probability of A/C use for a given reduction in temperatures. Dr. Rugh is currently involved in a global effort led by the Society of Automotive Engineers (SAE) to come up with an agreed upon method to determine life cycle climate performance. This effort is known as SAE's Improved Mobile Air Conditioning Cooperative Research Program. Dr. Rugh provided a draft analysis from Phoenix, showing the percent of time the A/C is in use for given ambient temperature ranges. As would be expected, at low ambient

<sup>2</sup> A 5°F reduction in interior temperature has been measured by Toyota when changing from a metallic blue paint with a solar reflectivity of 10 percent to one with a reflectivity of 20 percent. Table 1 shows NIR reflectivity of 0.77 for white paint. This could be applicable to all paints, and could probably be improved to reach values closer to 100 percent reflectivity. Therefore, even the metallic blue paint should be able to achieve a reflectivity of at least 50 percent. Thus, the anticipated CO<sub>2</sub> reduction should be conservative.

<sup>3</sup> Literature on cool paints and window glazings typically model the potential for downsizing the A/C unit that exists due to measured reductions in soak temperature. Statements of the amount of downsizing feasible for equivalent cooling times are typically followed by an associated reduction in CO<sub>2</sub> emissions. Dr. Akbari presumes improvements in emissions would result whether the A/C unit was downsized or the existing unit was simply used less frequently.

temperatures, very little A/C is used: As temperatures increase to around 18°C, A/C use begins to increase. Use continues to increase steadily until the A/C is in use nearly 100 percent of the time, around 38°C. During the rising portion of the curve, A/C use increases about 5 percent per °C. If it is presumed that increased ambient temperatures are associated with increased soak temperatures, it would be logical to correlate a reduction in soak temperature in the midsection of the graph with a reduction in A/C use. Thus, a reduction in temperature of about 2.7°C (5°F), as seen in the Toyota test, would be expected to result in 14 percent less A/C use when ambient temperatures are in the rising portion of the curve. Staff applied that figure to the methodology developed by Dr. Akbari, and found a predicted reduction in CO<sub>2</sub> emission from a 2.7°C reduction in temperature of 2.1 MT/yr, which is comparable to the estimate presented by Dr. Akbari.

The following bullets summarize the issue:

- Slightly over half of all solar energy is in the form of NIR radiation, which is not visible to the naked eye. Cool paints use pigments that have low absorptance of NIR while maintaining a variety of visible colors.
- The benefits of cool paints include:
  - Lower external surface temperatures, reducing burn hazard and the transfer of heat to the interior of the vehicle.
  - Lower interior temperatures, resulting in greater driver comfort and potentially reduced A/C demand.
  - Potential to reduce size of air conditioner. According to LBNL staff, a vehicle's A/C is currently designed to cool a black vehicle parked for 4 hours in the summer sun in Phoenix within a set time period. If that vehicle is painted with cool black paint, the soak temperature would be reduced and the A/C load reduced. Downsizing the A/C would allow it to operate at more efficient loads while maintaining desired interior temperatures.
  - Reduced use of and/or downsizing of an A/C would result in reduced GHG emissions. Analyses indicate a reduction of 2.1 to 2.4 MT/yr CO<sub>2</sub>e could be achieved for the light duty fleet with a relatively small improvement in solar reflectivity. Additional reductions for the medium and heavy duty fleets would likely increase this figure.
  - Possible increased lifespan of exterior paint, interior plastics and other materials

## **5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities**

There are few disbenefits to this technology beyond a slight increase in coating cost. This may be more than offset by reduced A/C use or A/C downsizing, if this occurs. Cool paints currently cost about \$10 more per vehicle than traditional paints. Literature indicates these paints are applied with standard equipment and methods. The small increased cost could be more than offset by a downsized A/C unit, and would be offset by improvements in operational costs due to reduced A/C use. In addition, the increased comfort should be of value to many consumers.

These paints would have the most benefit if used in conjunction with other technologies (e.g., window glazing, passive ventilation) to reduce a vehicle's interior temperatures. Therefore with the development of this rulemaking, staff will also evaluate other

technologies that will reduce the heat load on the vehicle's A/C and determine if it would be appropriate to include these technologies in the "cool paints" proposal.

## **6. Other Considerations:**

Cool paints can be formulated with existing paint formulations such that supply should not be an issue. BASF, DuPont, Sherwin Williams, many other paint manufacturers do have cool versions of at least some paints developed. Cool paints do not limit consumer choice of color. Cool paints use pigments that have low absorbance of the non-visible spectrum while maintaining the same variety of visible colors that consumers demand. Presently, cost and car maker acceptance appear to be the only show-stoppers for the use of cool paints and other complimentary cool car technologies.

An evaluation should be done to determine if the reformulated "cool paint" will result in an increased toxic exposure risk during the paint application process and disposal. Staff believes this exposure risk should be minimal due to the fact that research thus far, shows that "cool paints" can be formulated using existing pigments; however it is an issue that needs to be addressed during the formal rulemaking process.

|                         |                                |
|-------------------------|--------------------------------|
| <b>7. Division:</b>     | Mobile Source Control Division |
| <b>Staff Lead:</b>      | Marijke Bekken                 |
| <b>Section Manager:</b> | Sharon Lemieux                 |
| <b>Branch Chief:</b>    | Michael Carter                 |

## **8. References:**

*Akbari, Hashem, "Coatings for Cool Vehicles" Presentation, March 16, 2007*

*Lawrence Berkeley National Laboratory, Heat Island Group, <http://CoolColors.LBL.gov>*

*Rugh, J., "Assessing the Vehicle Level and National A/C Fuel Use Impact of Advanced Climate Control Technologies," International Energy Agency Workshop – Cooling Cars with Less Fuel, Paris, France, Oct. 23, 2006.*

# Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

## 1. Early Actions Strategy Name and Proponent

SUMMARY #            *B07*  
ID NUMBER:         *EJAC-14/SCAQMD-6/EA 2-16/ARB A-14*  
TITLE:                *GREEN PORTS*  
PROPONENT:        *2006 CAT REPORT AND STAKEHOLDER SUGGESTION*

## 2. Staff Recommendation

This measure was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, it is recommended that this measure be reclassified as a discrete early action. The Board date for consideration of this item is anticipated in 1<sup>st</sup> quarter of 2008.

Staff proposes to present the draft regulation to the Board as a measure to reduce nitrogen oxides (NO<sub>x</sub>) and diesel particulate (PM) emissions and to quantify the associated (carbon dioxide) CO<sub>2</sub> emission reductions. By focusing on NO<sub>x</sub> and PM reductions, staff will address the local and regional health impacts of ships docked in California's ports, including any disproportionate impacts those emissions may have on surrounding communities.

## 3. Early Action Description

This early action allows docked ships to shut off their auxiliary engines by plugging into shoreside electrical outlets or other technologies. The Air Resources Board identified port electrification as a strategy to reduce the emissions of nitrogen oxides (NO<sub>x</sub>) and diesel particulate matter (PM) when the Board approved the Goods Movement Emission Reduction Plan in April 2006. Furthermore, the Climate Action Team (CAT) recommended port electrification as a greenhouse gas (GHG) emission reduction strategy in 2006.

While a ship is docked at a berth, or "hotelled," it continuously runs at least one auxiliary engine to power lighting, ventilation, pumps, communication, and other onboard equipment. Ships can hotel for several hours or several days.

Port electrification provides an alternative source of power for these ships while they are docked. The ships can use cables to receive electricity from the shore, thereby allowing them to shut off their auxiliary engines, reducing emissions of air pollutants. Although the generation of electricity creates emissions—typically from power plants located elsewhere—these emissions are much less than those from the auxiliary engines located on the ships. Port electrification of a ship can reduce its emissions of NO<sub>x</sub> and diesel PM by more than 90 percent. Greenhouse gas (GHG) emissions, as carbon dioxide (CO<sub>2</sub>), are also reduced, depending on the source of electricity provided to the berth.

To be an attractive candidate for shore electrification, a ship must visit a California port frequently, spend a sufficient number of hours in berth, and have an ample power demand while docked. The ship categories that typically meet these criteria are container ships, passenger ships, and refrigerated cargo ships. (Passenger ships, although in port for only about 10 hours, visit frequently and have tremendous power needs.) Ship categories that are not attractive candidates include bulk cargo ships, vehicle carriers, and most tankers. The ports that receive numerous calls by container ships, passenger ships, and refrigerated cargo ships—and therefore the ports most likely to employ port electrification—are Los Angeles, Long Beach, San Diego, Oakland, San Francisco, and Hueneme.

ARB staff is currently working with ports, ship operators, utility companies, local air districts, and other interested stakeholders to develop a regulation to reduce emissions from ships while docked. Although the proposed regulation will allow alternative technologies to reduce emissions, the key component of the regulation will be port electrification. Staff expects to take the proposed regulation to the Board for its consideration by the end of 2007.

#### 4. Potential Emission Reductions

ARB staff is pursuing the port electrification strategy as a measure to reduce NO<sub>x</sub> and diesel PM emissions. This strategy was identified in the Goods Movement Emissions Reduction Plan (GMERP), approved by the Board in April 2006. The reduction of these pollutants is essential for protecting public health near California's ports and for the South Coast Air Basin to eventually achieve and maintain health-based ambient air quality standards for ozone and fine particulate matter. The reduction of CO<sub>2</sub> is a co-benefit of the proposed at-berth emission reduction regulation.

Although the proposed regulation is not yet fully developed, staff estimates that the regulation may result in the following emission reductions:

| <b>Pollutant</b>                      | <b>2015</b> | <b>2020</b> |
|---------------------------------------|-------------|-------------|
| NO <sub>x</sub> (Tons)                | 15,000      | 19,000      |
| Diesel PM (Tons)                      | 400         | 500         |
| CO <sub>2</sub> (Million Metric Tons) | 0.3         | 0.5         |

Staff expects port electrification to achieve emission reductions in 2010—largely due to the commitments of the Port of Los Angeles and the Port of Long Beach through their Clean Air Action Plan—however, the emission reductions from the proposed regulation will not be substantial until after 2010.

The potential CO<sub>2</sub> emission reductions of port electrification are dependent on the source of the electricity provided to the port. If the electricity portfolio of the utility company has a significant portion of renewable sources, such as wind, solar, or biomass, then the CO<sub>2</sub> reductions may be substantial. Similarly, if the portfolio contains sources of electricity that generate considerable amounts of CO<sub>2</sub>—say, out-of-state coal-fired plants—then the potential CO<sub>2</sub> emissions would be diminished.

For the purpose of this analysis, ARB staff used a CO<sub>2</sub> emission factor of 0.25 MMT CO<sub>2</sub>/MW-hr for the electrical grid and 0.69 MMT CO<sub>2</sub>/MW-hr for the auxiliary engines. Staff will consider utility-specific CO<sub>2</sub> emissions and marginal electricity generation CO<sub>2</sub> emissions (typically combined-cycle gas turbines) as the development of the regulation proceeds.

As mentioned earlier, the proposed regulation will allow alternative technologies to achieve required emission reductions. These alternatives may include ship-side technologies, such as post-combustion devices, alternative fuels, or cleaner engines, or shore-side technologies, including distributed generation or emission-capture-and-treatment devices. These technologies will probably be less effective in reducing GHG emissions when compared to port electrification; however, their overall deployment and impact are uncertain.

As a GHG emission reduction strategy, port electrification has the potential to reduce CO<sub>2</sub> emissions on the order of 0.3 to 0.5 MMTCO<sub>2</sub> per year. This estimate does not consider the climate benefit associated with reduction of black carbon, a component of diesel PM.

## 5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

Staff estimates that port electrification, as currently proposed, will cost more than \$1.2 billion, roughly one-third of that cost borne by the ports and terminals, two-thirds by the ship operators.

The growth in port activity—especially the substantial increase in containers expected to be handled by the ports and the projected surge in cruise-ship vacations—will have a significant impact on the number of ships that must be built or retrofitted to accommodate port electrification. ARB staff estimates the number of ships to be affected by the proposed regulation as:

| <b>Ships Affected</b> | <b>2015</b> | <b>2020</b> |
|-----------------------|-------------|-------------|
| Container             | 500         | 1,200       |
| Passenger             | 76          | 110         |
| Refrigerated Cargo    | 10          | 25          |

In addition to the recovery of that capital expenditure, annual operating expenses will include labor costs necessary to connect and disconnect the ships to shore power and the cost of the electricity itself. Fuel savings realized by shutting down the auxiliary engines will help offset the electricity costs.

Staff estimates that the annual costs of port electrification are as follows:

| <b>Annual Costs</b> | <b>2015</b>          | <b>2020</b>          |
|---------------------|----------------------|----------------------|
| Capital Costs       | \$148 million        | \$250 million        |
| Operating Costs     | \$42 million         | \$ 75 million        |
| <b>Total</b>        | <b>\$190 million</b> | <b>\$325 million</b> |

As mentioned above, port electrification is considered foremost a measure to reduce NO<sub>x</sub> and diesel PM emissions with GHG emission reductions being a co-benefit. The cost effectiveness of port electrification for 2020 is estimated at \$17,000/ ton for NO<sub>x</sub> or \$640,000/ ton for PM. These values represent the cost of the regulation completely allocated to either NO<sub>x</sub> or diesel PM; a sharing of the total costs between these two pollutants would further enhance their cost effectiveness.

If NO<sub>x</sub> and diesel PM emission reductions were not considered, and port electrification were considered solely as a GHG emission reduction measure, the cost effectiveness in 2020 would be \$650/MT CO<sub>2</sub>.

Staff proposes to present the draft regulation to the Board as a measure to reduce NO<sub>x</sub> and diesel PM and to quantify the associated co-benefit of CO<sub>2</sub> emission reductions. By focusing on NO<sub>x</sub> and PM reductions, staff will address the local and regional health impacts of ships docked in California's ports, including any disproportionate impacts those emissions may have on surrounding communities.

## **6. Technical Feasibility**

Port electrification is a proven technology. The U.S. Navy has been employing it worldwide for decades. Princess Cruise Lines currently uses port electrification in Juneau, AK and Seattle, WA, as does China Shipping at the Port of Los Angeles (POLA). The NYK Atlas has recently plugged in at POLA, and British Petroleum is expected to utilize port electrification by the end of the year at the Port of Long Beach for two of its diesel-electric tankers.

Although technically feasible, port electrification is not without its challenges, including the availability of electricity, the standardization of electrical hookups, and sufficient visits to electrified berths by retrofitted ships to make the emissions reductions cost-effective. Staff has been discussing the necessary electrical infrastructure and supply with the major ports and utility companies. The International Maritime Organization (IMO) is considering standard electrical connections for port electrification, and several California ports and other organizations are participating in that effort.

## **7. Additional Considerations**

California will be the first state to require port electrification, or its equivalent, if the Board adopts a proposed regulation within the next six months. Current port electrification projects within California and the United States have been required on a case-by-case basis.

The requirement to reduce emissions from ships while docked at California ports is clearly within the jurisdiction of the Air Resources Board. Port electrification has been identified as a strategy to reduce NO<sub>x</sub> and diesel PM in the Goods Movement Emission Reduction Plan and as a GHG emission reduction strategy by the CAT. Staff will bring a proposed regulation to the Board within the next six months.

**8. Division:** Stationary Source Division  
**Staff Lead:** Grant Chin

**Section Manager:** Mike Waugh  
**Branch Chief:** Mike Tollstrup

**9. References:**

[\*Draft Evaluation of Cold-Ironing Ocean-Going Vessels at California Ports \(ARB, March 2006\)\*](#)

*Documentation to Climate Action Team, December 2006*

# Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

## 1. Early Action Strategy Name and Proponent

SUMMARY #            *B08*  
ID NUMBER:         *EJAC-7/ARB 2-17*  
TITLE:                *TRANSPORT REFRIGERATION UNITS, ELECTRIC STANDBY*  
PROONENT:         *2006 CAT REPORT AND ENVIRONMENTAL JUSTICE*  
                             *ADVISORY COMMITTEE*

## 2. Staff Recommendation

This strategy was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, no change in the classification of this strategy is recommended. Costs for this strategy are high and new information indicates costs may be 30 to 50 percent higher than originally estimated. An extensive amount of coordination with industry remains to be completed before any regulatory action can proceed. This is due to a variety of factors, including the lack of industry standards for electric power use on transport refrigeration units (TRUs). For example, more than four optional voltages are used, along with both single phase and 3-phase frequencies, and many electric power plug configurations are in use (see Part 7 for more information). Therefore, a Board hearing date is not indicated.

## 3. Description

Transport refrigeration units are refrigeration systems powered by integral internal combustion engines designed to control the environment of temperature sensitive products that are transported in trucks, trailers, shipping containers, and railcars. In 2004, the TRU Airborne Toxic Control Measure (ATCM) was adopted to reduce diesel particulate matter (PM) emissions from TRU engines. ARB staff is currently implementing this ATCM. As conceived, this strategy would go beyond current ATCM requirements with a regulatory action to require that no TRU-equipped trucks, trailers, shipping containers, or railcars that are used at a large distribution center for outbound loads would be allowed to be powered by internal combustion engines for more than 30 minutes in a 24-hour period.

An optional component of this strategy would prohibit the use of internal-combustion engine-powered TRUs on trucks, trailers, shipping containers, and railcars from being used for extended cold storage at California distribution centers, grocery stores, and elsewhere. This practice occurs during the 4-to-6 week period before all of the major holidays because distribution center cold storage warehouse capacity is exceeded at about 30 percent of the distribution facilities and at an unknown number of grocery stores.

#### **4. Potential Emission Reductions**

For this strategy, staff estimates a reduction of 3.4 to 4.3 million gallons of diesel fuel used per year (with 51 to 64 GWh of new electricity use); the optional component (extended cold storage prohibition) would result in an additional reduction of 1.7 million gallons of diesel fuel used per year (with 26 GWh new electricity use). This strategy would also provide emission reduction co-benefits due to reduced diesel engine operating times; therefore, emissions of ozone precursors and diesel PM particulates would also be reduced. However, ARB staff estimates only about 0.04 million metric tons per year of CO<sub>2</sub> reductions could be achieved (0.45 million metric tons total by 2020).

#### **5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities**

Capital costs are estimated to be \$105 million for the first year and \$3.1 to \$3.6 million per year thereafter. The optional component would require an additional one-time capital cost of \$44 million. New information indicates capital costs may be 30 to 50 percent higher than these early estimates. Without including these potential increases, inflation or discount factors, ARB staff estimates rough annual costs at \$16.7 million per year (total accrued costs, with savings, would be approximately \$167 million in 2020). Staff is still working on refining cost and is not able to provide a cost-effectiveness estimate at this time.

#### **6. Technical Feasibility**

Compliance is a critical issue which will most likely require the use of various technologies in order to ensure that adequate enforcement of the regulation occurs. Technologies exist that could be applied toward automated compliance assurance and reporting systems, but it may take several years to develop and test the reliability of such systems such that they could be used for this application. Additional regulatory action may also be necessary to ensure these compliance assurance systems provide an enforceable reporting mechanism.

#### **7. Additional Considerations**

Industry standards need to be developed and adopted to address compatibility issues, plug types, and configurations. Although electric standby (E/S) technology is available for some TRU models, less than one percent of trailer TRUs are currently equipped with E/S and retrofitting with E/S is extremely expensive and has never been attempted. Extensive design and development work is needed before E/S use could be required. Most existing TRU models will need to be redesigned to use smaller, more efficient refrigeration compressors or to use larger, more powerful electric motors to provide enough capacity for quick initial trailer cool-down prior to loading perishable goods. Current E/S designs use under-powered electric motors that are intended only to maintain a temperature set point after the diesel engine completes the initial chill down. Additionally, further investigation on the feasibility of prohibiting the use of diesel-powered TRUs for extended cold storage is needed as it may require a significant change in business practices and have unforeseen economic impacts.

**8. Division:** Stationary Source Division  
**Staff Lead:** Rod Hill  
**Section Manager:** Richard Boyd  
**Branch Chief:** Dan Donohoue

# Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

## 1. Early Actions Strategy Name and Proponent

SUMMARY #            *B09*  
ID NUMBER:         *EJAC-9/ARB 2-19*  
TITLE:                *TRUCK STOP ELECTRIFICATION WITH INCENTIVES FOR TRUCKERS*  
PROPONENT:        *ENVIRONMENTAL JUSTICE ADVISORY COMMITTEE*

## 2. Staff Recommendation

This measure was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, no change in the classification of this measure is recommended. The Board date for consideration of this item is waiting to be determinate.

Staff recommends that ARB considers an incentive-based strategy to expedite a comprehensive deployment of on-shore electric power infrastructure to eliminate idling emissions from heavy-duty trucks. This incentive program must consider the existing requirements of the idling regulations in order to design an approach that would yield surplus emissions through the use of financial incentives. The incentives could be structured to pay a portion of the plug-in usage fee either to the truckers or to the technology vendors. The advantage of this strategy would be the elimination (exclusive of power plant emissions) of greenhouse gas and criteria pollutant emissions resulting from truck idling activities. This approach would also provide an alternative for the trucking industry to not just comply with the idling requirements, but would allow them to go beyond those requirements to achieve zero emission through the use of financial incentives. The disadvantage of this strategy would be the high costs to obtain relatively small incremental benefits since existing regulations have already established very low emission thresholds for this source category.

## 3. Early Action Description

This strategy would require truck stops to install electrical power infrastructure (i.e., on-shore electrical power) to reduce heavy-duty trucks idling emissions, perhaps through the use of financial incentives. On-shore electric power involves the electrification of truck parking spaces to provide power for heating, cooling and on-board truck accessories. Affected entities of this strategy include owners and/or operators of heavy-duty trucks, truck stops owners and technology vendors.

Heavy-duty trucks idle their engines an estimated 6 hours per day, resulting in emissions of criteria pollutants and greenhouse gases. These emissions could be eliminated with the proposed electrification strategy as a result of eliminating the combustion of diesel fuel from either the truck engine or the auxiliary power unit (APU) engine. The ARB has already adopted regulations limiting the idling time of heavy-duty trucks unless the truck

is installed with appropriate low-emission technology. Starting in 2008, all trucks must comply with a 5-minute idling limit unless it has a certified APU coupled with a PM trap. Engine manufacturers also have the option of certifying model year 2008 and newer main truck engines to a low idling NOx emission level of 30 grams per hour (ARB, 2005). Since the existing regulations have already set limits and requirements on truck idling activities, this proposed strategy would provide additional emission reductions beyond those regulations by eliminating the emissions resulting from operation of the APU, or from low-idling emission engines.

Currently, there are already two on-shore power technologies that have been commercially established and have been used to eliminate truck idling emissions. The two technologies are commonly referred to as on-board power infrastructure and off-board infrastructure technologies.

On-board power infrastructure provides trucks with 110-volt AC electrical power at truck stops to run the air conditioning, heating and on-board accessories. This would require truck stops to be equipped with electrical outlets throughout the parking spaces and trucks need to be equipped or retrofitted with inverterchargers, electrical power connections and electrically driven heating and air conditioning units. The drawbacks of this approach include the high initial infrastructure cost, cost for equipment add-ons to trucks, and its availability, which is limited to where the infrastructure is installed. The aftermarket cost for add-ons and installation is about \$4,000 per truck and power infrastructure installation is about \$3,500 to \$6,000 per truck parking space depending on the number of power pedestals installed (Perrot, et al, 2004).

Off-board power infrastructure provides 110-volt AC electrical power through an externally installed heating and air conditioning unit, as well as hook-ups for basic telephone, internet and television services at each truck parking space. The unit is connected to the truck through a console installed to the truck window using a template insert. The console contains all the necessary connections and controls, including a card reader for the billing system. Currently the usage fee for basic services range from \$1.25 to \$1.50 per hour. The off-board power infrastructure installation cost is approximately \$12,000 to \$20,000 per parking space depending on the number of parking spaces installed (Antares, 2005). The advantage of this system is that the truck does not need to be modified with any alternative cab comfort technology, resulting in immediate benefits to the truck owner using the service through reduced fuel consumption and maintenance savings.

This strategy could be crafted as a regulation requiring all truck stops to install electric infrastructure that could be used by truckers to eliminate truck engine idling. To be effective, that regulation would also need to require the truckers to use the electric infrastructure for their idling needs instead of idling the truck engine or using the APU. However, since ARB already has existing idling regulations, one of which has already been implemented and the other will become effective in January 2008, it will be challenging to develop another regulation on top of the existing idling regulation. A less contentious approach would be through an incentive-based program to spur the installation of the appropriate electric infrastructure that would allow truckers the option to "plug in" when they park at these truck stops.

ARB has already had direct experience in implementing an incentive-based on-shore power infrastructure program. ARB executed a grant with IdleAire, a company that

developed an off-board power infrastructure technology, to assist in the installation and operation of off-board power infrastructure at various truck stops located in the San Joaquin Valley. The grant, totaling \$1,334,536, was used to pay for usage (\$1.50 per hour) of the IdleAire device at the 415 parking spaces at six truck stops that are spread throughout the San Joaquin Valley. The South Coast Air Quality Management District (SCAQMD) has also funded IdleAire projects in the South Coast with funding from the Carl Moyer Program and the U.S. EPA. In addition to paying for usage, at a rate of \$3.94 per hour, the SCAQMD program also pays for a portion of the installation cost (\$8,726 per unit) of the IdleAire power unit.

#### **4. Potential Emission Reductions**

The existing truck idling regulation limits idling time from heavy-duty trucks to 5 minutes unless the truck is equipped with an APU coupled with a particulate trap or, alternately, unless the truck is a 2008 and later model year that is certified to the low idling NOx emission standard of 30 grams per hour. Because of this requirement, the NOx idling emission rate of 30 grams per hour was used as the baseline emission level. Since existing idling regulations do not specify optional idling emission rates for pollutants other than NOx emissions, the truck baseline idling emission levels for other pollutants such as HC, PM, and CO<sub>2</sub> were established using EMFAC2002 idling emission rates. The surplus emission reductions are calculated as going from these baseline levels to a zero emission level for each truck stop parking space that is electrified.

Based on data from Report to Congress of Adequacy of Parking Facilities, there is currently about 7,500 spaces at truck stops and 1,300 spaces in Caltrans public rest areas. Currently, about 900 parking spaces at truck stops are installed with electric power infrastructure, resulting in an estimated 2010 annual reduction of about 55,000 tons of CO<sub>2</sub> per year (0.055 MMTCO<sub>2</sub>E). If the remaining truck stop parking spaces are electrified, an additional annual reduction of about 405,000 tons of CO<sub>2</sub> (0.4 MMTCO<sub>2</sub>E) would result. Depending on the expected growth of available parking spaces at truck stops, the 2020 emission benefits could be adjusted accordingly. The expected CO<sub>2</sub> emission reduction from this strategy, if fully implemented, could be on the order of >0.1 to 1.0 MMTCO<sub>2</sub>E. Emission reductions of criteria pollutants (HC, NOx, and PM) are estimated to be about 530, 1,300, and 120 tons per year, respectively, in 2010.

#### **5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities**

Given the cost of the existing on-shore electric power infrastructure technology and the expected baseline emission rates, it is estimated that the cost to reduce CO<sub>2</sub> emissions to range from a low of about \$135 per metric ton to a high of about \$359 per metric ton. There are about 6,600 parking spaces at truck stops and about 1,300 parking spaces in Caltrans public rest areas that are currently do not have electric power infrastructure, for a total of about 7,900 truck non-electrified parking spaces. Assuming the cost of on-shore power infrastructure to range from \$7,500 to \$20,000, including the cost of on-truck equipment in the case of the on-board power infrastructure technology, the total cost to electrify all 6,600 parking spaces at truck stops would be about \$49,500,000 to \$132,000,000. If the 1,300 parking spaces at Caltrans public rest areas are also to be installed with on-shore electric power infrastructure, it would cost an additional \$9,750,000 to \$26,000,000.

A requirement for an on-shore electric power infrastructure would impact truck stop owners, truck drivers, and technology vendors. The economic burden on truck stop owners would depend on how they structured their approach towards establishing the required infrastructure. They could purchase the equipment and have it installed at their facilities, or they could opt to lease the parking spaces to technology vendors for them to install the equipment. The cost to truckers could range from the cost to install the necessary equipment on their trucks in the case of an on-board technology to simply just paying for the hourly cost of plugging in when they use the facility. The cost to technology vendors would be the cost to manufacture, install, and operate the power infrastructure.

## **6. Technical Feasibility**

On-shore electric power infrastructure is an established, proven commercial technology. This technology is currently being deployed at various truck stops throughout the country. In California, approximately 900 truck stop parking spaces already have on-shore electric power infrastructure. The main obstacle to more widespread deployment of this technology appears to be the relatively high initial cost of installing the necessary infrastructure.

## **7. Additional Considerations**

Additional analysis is needed before deciding on an implementation path. It is possible that other jurisdictions have taken this action as an incentive program. Also, this strategy clearly falls under ARB jurisdiction and authority as idling limits have been adopted. Although an incentive program appears to be the best option, a regulation could be developed in the next 18 months, making the strategy a discrete early action.

Affected Entities: Truck stop owners, truck drivers, technology vendors

Trade Associations: Trucking associations, utilities companies

Government Agencies to coordinate with: Local air districts, local governments regarding permitting requirements

**8. Division:** Mobile Source Control Division  
**Staff Lead:** Bob Nguyen  
**Section Manager:** John Kato  
**Branch Chief:** Jack Kitowski

## **9. References:**

*ARB, Notice of Public Hearing to Consider Requirements to Reduce Idling Emissions from New and In-Use Trucks, Beginning in 2008, Sacramento, September 1, 2005*

# Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

## 1. Early Actions Strategy Name and Proponent

SUMMARY #            *B10*  
ID NUMBER:         *EA 2-20*  
TITLE:                *TIRE PRESSURE PROGRAM*  
PROONENT:         *AIR RESOURCES BOARD STAFF*

## 2. Staff Recommendation

This measure was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, it is recommended that this measure be reclassified as a discrete early action. The Board date for consideration of this item is anticipated in 1<sup>st</sup> quarter of 2009.

Maintaining a vehicle's tire pressure to the manufacturer's recommended specifications is a practical strategy to achieving early greenhouse gas (GHG) emission reductions. Current Federal law requires auto manufacturers to install tire pressure monitoring systems in all new vehicles beginning September 1, 2007. Staff recommends that the ARB investigate strategies to ensure that the tire pressures in older vehicles are also monitored, as well as requiring the tires to be checked and inflated at regular service intervals. One potential strategy would be to require all vehicle service facilities, such as, dealerships, maintenance garages, and smog check stations, to check and inflate tires.

Staff also recommends that the feasibility of conducting an extensive outreach program be investigated. The outreach program could entail placards being placed above each fueling dispenser to encourage drivers to properly maintain their tires each month. The placards would highlight the amount of money consumers could save as a result of lower fuel consumption, as well as, how each consumer is doing their part to help prevent climate change.

## 3. Early Action Description

According to the National Highway Traffic Safety Administration (NHTSA), 74% of all vehicles have at least one significantly under inflated tire<sup>1</sup>. The U.S. Department of Energy (DOE), California Energy Commission (CEC), and NHTSA, state that every 1 pound per square inch (PSI) drop in tire pressure equals an approximate 0.4% drop in a vehicle's gas mileage. Establishing a program to monitor and correct vehicle tire pressure could save Californians a minimum of 61 million gallons of fuel, which equates to 0.54 MMT of CO<sub>2</sub> emissions in 2010 (first year of implementation) and 22.5 million gallons of fuel and 0.20 MMT of CO<sub>2</sub> emissions in 2020. Potential savings from a program that was 100 percent effective in ensuring proper tire inflation are on the order of 96 millions gallons of fuel saved in 2010.

#### **4. Potential Emission Reductions**

The GHG emission benefit of this program is associated with the reduction in gallons of fuel consumed by California drivers. The reduction in gallons of fuel consumed is based upon 10 million vehicles visiting a repair facility at least once a year and having their tires checked and inflated to the manufacturer's recommended pressure<sup>2</sup>. Approximately 74 percent of vehicles in California have under inflated tires, of which, 27 percent have at least one tire severely under inflated (25 percent or more of the manufacturer's recommended pressure)<sup>1</sup>. On average, a vehicle tire loses approximately 1 PSI per month<sup>2</sup>. For every loss of 1 PSI in tire pressure, a corresponding loss in fuel economy of 0.4% can be expected<sup>2</sup>.

It is estimated that Californians will consume approximately 14.1 billion gallons of gasoline in 2010 and 16.2 billion gallons in 2020<sup>3</sup>. In 2010 (first year of implementation), the predicted reduction in the consumption of fuel is 61 million gallons which equates to 0.54 MMT of CO<sub>2</sub>. This is based on 27 percent of vehicles having at least one tire severely under-inflated, 47 percent having tires under inflated by 1 PSI, and 26 percent having the correct pressure<sup>1</sup>. In 2020, emissions reductions are expected to be lower due to the recommended strategy and outreach programs and the federal requirement for tire pressure monitoring systems in all new vehicles. The reduction in gallons of fuel consumed will be approximately 22.5 million gallons which equals 0.20 MMT of CO<sub>2</sub>.

#### **5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities**

Costs associated with this program include public outreach and education, equipment costs such as compressors and accessories, and labor. One study suggested the labor rate to check and inflate tires will be approximately \$3.75 per vehicle<sup>2</sup>. In addition, some vehicle repair facilities may be required to purchase an air compressor and accessories at an approximate cost of \$500<sup>4</sup>.

Retrofit technologies exist that can monitor tire pressure at costs ranging from \$20 to \$600 depending on the system and installation variables (i.e., make and model of vehicle, brakes, ABS, hourly installation rate, etc.)<sup>4</sup>. Additional staff work is needed to determine the feasibility and cost effectiveness of retrofits.

#### **6. Technical Feasibility**

There are no technology limitations for this strategy.

#### **7. Additional Considerations**

Several State and Federal agencies have public outreach websites that highlight the relationship between tire pressure and saving money (e.g., U.S. DOT – It All Adds Up, CEC – Fuel Efficient Tire Program, California's Energy Efficiency Program – Flex Your Power, IWMB – National Tire Safety Week). Enforcement of this type of strategy will be extremely difficult.

Affected Entities: California's vehicle repair facilities and refueling stations and vehicle owners.

Government Agencies to coordinate with: U.S. DOT, CEC, IWMB, and others as outreach information becomes available.

**8. Division:** Stationary Source Division  
**Staff Lead:** Theresa Anderson  
Wayne Sobieralski  
**Section Manager:** Mike Miguel  
**Branch Chief:** Mike Tollstrup

**9. References:**

<sup>1</sup> U.S. Department of Transportation, NPRM on Tire Pressure Monitoring System FMVSS No. 138, 09/2004

<sup>2</sup> California Inspection and Maintenance Review Committee, Review of the Smog Check Program, 11/2006

<sup>3</sup> Based on Air Resources Board's California Emissions Forecasting System, Population and Vehicle Trends Report, Statewide Daily Vehicle Fuel Consumption (Gasoline), EMFAC 2002, Version 2.2

<sup>4</sup> Based on retail quotes obtained by the Air Resources Board, 07/2007

# Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

## 1. Early Actions Strategy Name and Proponent

SUMMARY #            *B11*  
ID NUMBER:         *EJAC- 11/ARB 2-22*  
TITLE:                *REQUIRE LOW GWP REFRIGERANTS FOR NEW MACS<sup>1</sup>*  
PROPONENT:        *2006 CAT REPORT AND ENVIRONMENTAL JUSTICE  
ADVISORY COMMITTEE*

## 2. Staff Recommendation

This measure was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, no change in the classification of this measure is recommended. The Board date for consideration of this item is anticipated in 4<sup>th</sup> quarter of 2010.

This strategy is also not a stand-alone measure. It is anticipated to be integrated into larger new measures focused on new vehicle GHG emission standards (e.g., *Pavley II* described as Summary # B33, page B-110 later in this appendix).

The central premise of the proposed strategy is the replacement of high global warming potential (GWP) refrigerants used in California's mobile air conditioning systems (MACS) with lower GWP alternatives that also represent better lifecycle climate performance (LCCP) than the current refrigerant. MACS in today's motor vehicles use nearly universally the refrigerant HFC-134a with a GWP of 1,300. A two-fold approach will be explored under the proposed new regulation. First, the core of the strategy would focus on developing new regulations requiring that new MACS use refrigerants with a lower GWP (e.g., 150 or less) in new vehicles currently not subject to the existing vehicle GHG emission standards (AB 1493). For vehicles subject to AB 1493, this strategy would explore further MACS improvements after the regulation is fully phased in 2016. Second, staff will explore the potential climate benefits from a universal phase out of HFC-134a (or other high GWP refrigerants) used in other remaining vehicle classes in the California fleet such as heavy-duty on- and off-road vehicles including new as well as in-use systems. Again, the identification of suitable alternatives would be based on lifecycle climate performance.

Alternative refrigerant development has been a highly contested arena in recent times. Driven primarily by Europe's landmark directive to phase out the use of HFC-134a in the MACSs of new vehicle types starting in 2011, several low GWP refrigerants are currently

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<sup>1</sup> New alternative low GWP refrigerants in MACS are desired to the extent that these alternatives have lifecycle climate performance (LCCP) that exceeds the performance of the current refrigerant HFC-134a. Thus, new low GWP refrigerants are sought in systems that leak less and are more efficient than current systems.

under investigation and evaluation for toxicity, safety, energy efficiency, and technical feasibility by multiple industry entities. Identification of an eligible replacement for the European car market, the largest in the world, would boost efforts in California and could accelerate the implementation of new regulations mitigating the impact of refrigerants in MACS.

### **3. Early Action Description**

This strategy explores the phase out of HFC-134a in all MACS in new vehicles certified for sale in California (heavy- and light-duty, on- and off-road) with the intent to reduce direct and indirect emission impacts and promote only the use of alternative refrigerants with superior lifecycle climate performance. Opportunities in the in-use fleet will also be evaluated.

Regulation of refrigerants is happening globally. The European Union (EU) is taking the lead. In 2006, the European Parliament and the Council decided that the dates for the phase-out of refrigerant HFC-134a in the European community shall be set at January 1, 2011 for new types of vehicles and January 1, 2017 for all new vehicles<sup>1</sup>. The US EPA's I-MAC Program<sup>2</sup> has generated significant debate and progress regarding alternative refrigerants and the options for the US car MACS market with the best lifecycle climate performance. Extensive cooperation between government agencies, NGOs, and industry is needed to accomplish this strategy and fully realize its benefits.

### **4. Potential Emission Reductions**

The proposed strategy was included in the Climate Action Team report of March 2006 and it emerged from ARB's regulatory work for the motor vehicle greenhouse gas emissions regulation (AB1493). That work suggests that potential GHG emission reductions for a universal phase out of HFC-134a in new and in-used MACS in California are on the order of 2.5 MMTCO<sub>2</sub>E by 2020. However, the uncertainty with the estimate is on the order of 50%.

### **5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities**

Preliminary cost estimates were developed for the revisions to the Climate Action Team Report of March 2006 that ARB and other agencies are undertaking. The numbers generated for that report are first-order estimates based on simple assumptions gleaned from the published literature about alternative MACS. Only estimated capital costs were considered. Additional staff analysis is needed to determine operating costs, cost savings, and economic impacts. The air conditioning system life is expected to be the same as current systems. Capital costs for the introduction of new refrigerants in the California fleet were estimated to be on the order of \$150 million by in 2020 based on assumptions that changes begin to phase in around 2013. This estimate is based on an incremental cost per vehicle of €20 to €25 per LDV in 2003<sup>3</sup> and is also applied to the other vehicle categories. For the HFC-152a alternative refrigerant, it is not expected that maintenance costs will change significantly or that there would be cost implications when converting an existing HFC-134a system design to use HFC-152a since development is fairly advanced. Selection of some other alternative refrigerants, for example CO<sub>2</sub>, could be significantly costlier. Incremental energy consumption estimates are not presented here. The reference below cites a potential 10% reduction in energy consumption for the

HFC-152a alternative for LDVs, but this will almost certainly vary significantly with vehicle category, engine type, operating cycle, extent of optimization achieved during system redesign, etc. Also, energy consumption for some other alternative refrigerant selections, for example CO<sub>2</sub>-refrigerant systems, can actually show an increase under some operating conditions. Significant additional analysis is needed to enable and improve cost and performance estimates of the various alternative technologies.

## 6. Technical Feasibility

New HFC refrigerants with GWP values less than 150, such as those currently under development for the US market by Honeywell and DuPont, and existing alternative refrigerants such as HFC-152a (with GWP approximately 120<sup>4</sup>) or R744 (CO<sub>2</sub>, GWP=1), are possible substitutes for HFC-134a in new vehicles. The feasibility of these low GWP refrigerants is being investigated and evaluated extensively by multiple entities. As suggested by the European directive, all indications are that a feasible refrigerant alternative to HFC-134a is eminent.

## 7. Additional Considerations

The EU regulation timeline calls for the phase out of HFC-134a beginning with new vehicles types in 2011. Thus, auto makers serving that market face at present time a critical go, no-go decision point regarding refrigerant selection for their systems.

The outcome of the AB1493 legal challenges, including the pending California waiver request to the US EPA, will impact significantly the form and function of the measure as proposed.

Each alternative new refrigerant will be evaluated from a lifecycle emissions standpoint to ensure that the net impact on greenhouse gas emissions is properly characterized and in order to promote improvements not only on refrigerant containment to minimize leakage, but also in system performance to reduce the parasitic impact of the MACS on the vehicle engine.

Affected Entities: Vehicle owners and operators, vehicle manufacturers, mobile air conditioning system repair facilities, mobile air conditioning system and component manufacturers, and air conditioning refrigerant manufacturers.

Government Agencies to coordinate with: U.S. EPA and the European Commission.

**8. Division:** Research Division  
**Staff Lead:** Pablo Cicero  
**Section Manager:** Tao Huai  
**Branch Chief:** Alberto Ayala

## 9. References:

<sup>1</sup> Schulte-Braucks, R., "Implementation of the R134a Phase Out," 2006 Mobile Air Conditioning Summit, Saalfelden, Austria, Feb. 17, 2006.

<sup>2</sup> *The I-MAC Program is a consortium of government, industry, academia, and other stakeholders led by the US EPA with the objective to develop superior and improved HFC-134a mobile air conditioning technology with 50% lower leakage and 30% greater efficiency than current production-ready systems.*

<sup>3</sup> *Alternative Refrigerants Assessment Workshop, Presentation at the SAE 2003 Alternative Refrigerant Systems Symposium, Phoenix, Arizona, July 14, 2003*

<sup>4</sup> *The GWP limit is intended to be that of HFC-152a, for which the IPCC 3rd Assessment Report suggested a 100-year forcing of 120. The more recent IPCC/TEAP Special Report on HFCs and PFCs suggests a direct forcing of 122.*

# Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

## 1. Early Actions Strategy Name and Proponent

SUMMARY #            *B12*  
ID NUMBER:         *EJAC-12/ARB 2-23*  
TITLE:                *ADDITION OF AC LEAK TEST AND REPAIR REQUIREMENTS TO SMOG CHECK*  
PROPONENT:        *2006 CAT REPORT AND ENVIRONMENTAL JUSTICE ADVISORY COMMITTEE*

## 2. Staff Recommendation

This measure was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, no change in the classification of this measure is recommended. The Board date for consideration of this item is anticipated in 1<sup>st</sup> quarter of 2011.

The strategy proposes to explore the addition of a new motor vehicle air conditioning system (MVACS) leak test and repair requirements to the existing California Smog Check program for HFC-based MVACSs. To the extent that a cost-benefit analysis supports this measure, implementation will require the 1) identification, selection and verification of one or more reliable and low cost HFC refrigerant leak detectors to be used in the Smog Check station setting; 2) development of a new Refrigerant Leak Check I/M procedure and protocol; 3) new and additional training of the Smog Check technicians including achieving appropriate technician A/C repair certification; and 4) working with the Bureau of Automotive Repair (BAR) of the Department of Consumer Affairs (DCA) for mandating the new procedure to be integrated into the statewide Smog Check program. Research will be needed to evaluate the feasibility of the new test and extensive discussions among multiple stakeholders, including first and foremost BAR and legislature staff are anticipated. For this reasons, this strategies cannot be developed before 2010 to meet the definition of a discrete early action.

## 3. Early Action Description

The proposed strategy will explore the addition of a refrigerant leak check to the “pass” criteria for the California vehicular inspection and maintenance (I/M) program, Smog Check, for all vehicles that undergo the test. As a result, all vehicles that pass Smog Check would have MACS that are either nearly leak-free or empty and excluded from further use of the AC system unless the leak is repaired. Vehicles that are determined to have unacceptable leak rates would be required to be repaired as a condition for registration. A similar requirement is already in place and enforced by some local air quality management districts. Thus, the proposed early action seeks to expand these local requirements statewide.

#### **4. Potential Emission Reductions**

The proposed strategy was included in the Climate Action Team report of March 2006 and it emerged from ARB's regulatory work for the motor vehicle greenhouse gas emissions regulation (AB1493). That work suggests that potential GHG emission reductions for a leak test and repair program in California are on the order of 0.45 MMTCO<sub>2</sub>E by 2020. However, the uncertainty with the estimate is on the order of 50%.

#### **5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities**

Some preliminary, but incomplete cost information exists. In 2005, BAR licensed approximately 9,700 Smog Check stations and almost 14,000 Smog Check technicians. Approximately 9.2 million Smog Check inspections were conducted at these Smog Check stations in 2005<sup>1</sup>. Each Smog Check station would have additional one-time estimated expenditures of about \$200-\$300 for each hand-held HFC leak detector. Technician training for AC service certification would cost up to \$280 per person. Based on above information, the total cost for equipment and training in California would be approximately \$6M; \$2M for equipment and \$4M for training. In addition, the leak test would add time to the current Smog Check test, impacting the shop and the customer. Finally, in the case where a MVACS is found to require repairs, the customer would incur additional and potentially significant costs. Technology is also rapidly evolving and improving. Today's MVACS are much tighter than older system and the industry, in response in part to regulatory interest, is proactively seeking refrigerant leak improvements in the system sold to car makers. These factors and many other economic impacts have not been thoroughly researched and additional time is needed to complete a full cost-benefit analysis of the proposed measure.

#### **6. Technical Feasibility**

There are several commercially available hand-held HFC leak detectors or "sniffers" on the market. These detectors are currently in use by the AC service and repair industry. The detectors would need to be demonstrated capable of reliable and accurate determination of refrigerant leaks in the Smog Check station setting at rates as determined in the proposed strategy. All MVACSs leak refrigerant naturally as the systems are not hermetic and deterioration is expected. A pass criterion based on a reasonable threshold leak rate requiring professional AC servicing or system disabling needs to be defined rigorously, perhaps as a fraction of the original system charge or other appropriate metric. The current commercially available sniffers can detect a concentration of refrigerant in a sample volume of some currently unknown combination of leakage and ambient air. Further investigation is needed to define the pass criterion for either a threshold concentration or leak rate.

Currently, the service industry standard established by the Society of Automotive Engineers, SAE J1628 Standard<sup>2</sup>, requires charging the AC with sufficient refrigerant prior to conducting a leak check. This procedure might be not suitable for the implementation of this strategy because the leak check would be conducted at Smog Check Stations, which normally do not have AC charging equipment. A new leak check protocol would be necessary. The measure must also require professional AC servicing or system disabling when leakage is found. Other methods, such as injection of dye gases, are under investigation.

## 7. Additional Considerations

ARB and BAR would need to work closely as both agencies share responsibility for Smog Check. Roles and responsibilities for both agencies in the context of the proposed strategy should further analysis suggest to proceed to full development and implementation will need to be defined.

**Affected Entities:** The I/M program operators at the Smog Check stations, the owners of all vehicles required to undergo I/M, shops that repair vehicular AC systems, BAR, and DCA, The I/M operators would have to become certified for AC maintenance, purchase new instruments for detection of HFC emissions, and adopt the new protocols for including the new test into the Smog Check procedure. BAR and DCA would be expected to develop a new I/M procedure and protocol to accommodate the new HFC leak check. The agencies would be impacted with additional enforcement requirements for the proposed strategy.

**8. Division:** Research Division  
**Staff Lead:** Tao Zhan  
**Section Manager:** Tao Huai  
**Branch Chief:** Alberto Ayala

## 9. References:

<sup>1</sup> *California Inspection and Maintenance Review Committee, Review of the Smog Check Program, September 29, 2006. [http://www.imreview.ca.gov/reports/final\\_report.pdf](http://www.imreview.ca.gov/reports/final_report.pdf)*

<sup>2</sup> *SAE J1628, Technician Procedure for Using Electronic Refrigerant Leak Detectors for Service of Mobile Air-Conditioning Systems, November 1998.*

# Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

## 1. Early Actions Strategy Name and Proponent

SUMMARY #            *B13*  
ID NUMBER:         *EA B-1, B-2*  
TITLE:                *WAFFLEMAT SYSTEMS*  
PROPONENT:        *STAKEHOLDER SUGGESTION*

## 2. Staff Recommendation

This measure is recommended for evaluation in the Scoping Plan which will be developed as a draft by mid-2008 and must be considered by the Board prior to January 1, 2009.

## 3. Early Action Description

The WAFFLEMAT System (registered trademark) is a set of interconnected WAFFLEBOXES equally spaced within the area of a new foundation. Concrete is then poured over the WAFFLEBOXES to create a concrete slab, thereby decreasing the volume of concrete used on new foundations and indirectly reducing the amount of CO<sub>2</sub> emitted from the production and transportation of Portland cement. The WAFFLEMAT System is advertised by the manufacturer to reduce CO<sub>2</sub> emissions by 20% when used for new residential home concrete slab foundations built on “marginal” soils (e.g., expansive soil, rocky soil, and/or hydro-collapsible soil), where an increase in slab thickness is required. The 20% CO<sub>2</sub> emission reduction was calculated by comparing the WAFFLEMAT System to a 10 inch uniform thickness slab. The actual percentages of CO<sub>2</sub> emission reductions will vary depending on the type and thickness of the slab which the WAFFLEMATs are compared against.

## 4. Potential Emission Reductions

Based on information from the manufacturer, ARB staff estimated that utilization of the WAFFLEMAT System on new residential home construction may reduce 3.5 metric tons (MT) of CO<sub>2</sub> emissions per slab for a 2,000 square foot home. If one assumes that 200,000 new residential homes are built each year in California, 25% of those homes are located on marginal soils and all 25% of those homes utilize the WAFFLEMAT System, there may be an annual CO<sub>2</sub> emission reduction of 0.18 million MT. Using 2008 as the baseline year, by 2010 there will be a cumulative 0.35 million MT CO<sub>2</sub> emission reduction and by 2020 there will be a 2.1 million MT CO<sub>2</sub> emission reduction. The primary purpose of the WAFFLEMAT System is to displace the total amount of concrete needed in a residential foundation and still meet or exceed construction requirements. In theory, if less concrete is needed, less needs to be produced. Emission reductions of oxides of nitrogen (NO<sub>x</sub>), particulate matter (PM), hydrocarbons, and carbon monoxide

(CO) will also be achieved with the use of the WAFFLEMAT System if it is assumed that overall less concrete will have to be used.

## **5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities**

The WAFFLEMAT System is estimated to cost \$1.20 per square foot of foundation. When compared to the cost of concrete for a 10 inch uniform thickness slab foundation on a 2,000 square foot footprint, the WAFFLEMAT System and its reduced volume of concrete may increase the price of a foundation by \$1,200. This equates to an approximate cost effectiveness of \$340 per MTCO<sub>2</sub>E. Additionally, the WAFFLEMAT System is advertised to provide cost savings in labor and ground preparation. ARB staff does not have information to quantify labor and ground preparation cost savings at this time.

The use of the WAFFLEMAT System is limited to use with marginal soils that generally require thicker slab foundations. Use of the WAFFLEMAT System with good soils may result in an increased use of concrete.

## **6. Technical Feasibility**

The WAFFLEMAT System was developed in 1995 and has had over 6.5 million square feet of concrete poured on it without one structural callback or failure. Pacific Housing Systems, Inc. (the distributor) and two engineering firms conducted studies to determine the design compliance and capability of the WAFFLEMAT System. Their results showed that the WAFFLEMAT System is technically feasible and has advantages over the traditional slab foundation in areas with marginal soils. Those advantages include, but are not limited to: the slab's ability to withstand larger cantilevers, reductions in labor costs, provides a more definite value for concrete costs, and reductions in overall installation time.

## **7. Additional Considerations**

- The use of the WAFFLEMAT System does not ensure reduction in the production of cement. CO<sub>2</sub> emission reductions are achieved with the use of the WAFFLEMAT System if cement plant operators reduce the production of Portland cement.
- Currently, not every new single-family residence home is built on marginal soils. We are not certain what percentage of new homes is built on marginal soils versus good soils. This could impact the CO<sub>2</sub> emission reduction estimates.
- Geotechnical engineers should be employed to recommend which foundation is suited for a site's soil type.
- ARB will need to work with other state and local agencies to ensure that the use of the WAFFLEMAT System meets building codes.
- ARB staff needs to work closely with legal to determine scope of authority for requiring the use of WAFFLEMAT Systems on new construction.

**8. Division:** Stationary Source Division  
**Staff Lead:** Alicia Violet  
**Section Manager:** Todd Wong  
**Branch Chief:** Michael Tollstrup

## **9. References:**

*Altshuler, Sam. "Lowering the Carbon Footprint When Using the Wafflemat System for Concrete Slab Foundations." Suncoast Post-tension - Pacific Housing System, Inc.. February 2007.*

*Charlton, Aurora. "Structural Engineering Case Study Report: Wafflemat Slab On Grade Post Tensioned Foundation System." Front Range Engineering, LLC. August 2006.*

*Cook, John. "Wafflemat System Design Considerations." Pacific Housing Systems, Inc. and MKM and Associates. April 2006.*

*Richards, Tom. "A Sales/Marketing Comparison and Positioning Statement of the WAFFLEMAT System to Post-Tensioned Slabs." Pacific Housing Systems, Inc.. March 2006.*

*Richards, Tom. Telephone Interview and email. July 16 and 24, 2007.*

*State of California – Business, Transportation, and Housing Agency; Department of Housing and Community Development. "California's Deepening Housing Crisis." June 2007.*

*Treanor, Rich. "Wafflemat Frequently Asked Questions." Pacific Housing Systems, Inc.. March 2006.*

# Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

## 1. Early Actions Strategy Name and Proponent

SUMMARY #            *B14*  
ID NUMBER:         *EJAC-15/ARB A-15*  
TITLE:                *GREEN SHIP INCENTIVE PROGRAM*  
PROPONENT:        *ENVIRONMENTAL JUSTICE ADVISORY COMMITTEE*

## 2. Staff Recommendation

This measure is recommended for evaluation in the Scoping Plan which will be developed as a draft by mid-2008 and must be considered by the Board prior to January 1, 2009. Evaluation as part of the Scoping Plan provides the most effective approach for fully considering the recommendation.

This measure is focused on reducing emissions of diesel particulate matter (PM) and nitrogen oxides (NOx) by phasing in the installation of emission control devices on new or existing vessels. While reductions in NOx and the elemental carbon portion of PM may reduce global warming, other aspects of this measure may contribute to it. For example, some of the emission control devices that can be used to significantly reduce PM and NOx will have fuel penalties associated with them, resulting in higher carbon dioxide (CO<sub>2</sub>) emissions. Other control strategies may reduce fuel consumption and CO<sub>2</sub> emissions. However, the overall effect of this measure on GHG emissions is expected to be minimal.

We do intend to analyze the potential to modify this measure to also address GHG emissions. However, for several reasons, this analysis cannot be conducted in a short timeframe due to the complexity of the technical and jurisdictional issues. For example, more advanced ship hull and propeller designs have been proposed as a way to reduce fuel consumption and CO<sub>2</sub> emissions in some studies. However, it is uncertain whether we can influence design changes on vessels built outside the United States. In addition, it is expected that ship operators would already incorporate such changes to reduce their operating expenses unless there are extremely high capital cost impacts or other barriers. Furthermore, to fully address GHG emissions, a review of all the various emissions from ships and their impact on global warming would need to be conducted. The relevant emissions would include CO<sub>2</sub>, methane, black carbon PM, sulfur oxides, refrigerants, and NOx. Some of these emissions contribute to global warming, while others have the opposite effect. In addition, some emissions effects may be localized whereas others are not. Finally, the potential control strategies for each type of emissions would need to be determined.

## 3. Early Action Description

This measure is included in the ARB's Emission Reduction Plan for Ports and Goods Movement. The measure, as currently proposed, seeks to reduce emissions of PM and

NOx by phasing in the use of cleaner ships at California ports. There are two levels of clean ships: “30/30 vessels” that are 30 percent lower in NOx and PM than current vessels meeting International Maritime Organization (IMO) standards, and “60/90 ships” that are 60 percent lower in PM and 90 percent lower in NOx than IMO compliant vessels. By 2020, the goal is to have clean ships make 90 percent of all California port visits, with 30/30 vessels making 40 percent of ship visits, and 60/90 vessels making 50 percent of ship visits. The ship operator would be expected to choose the specific emission control devices. Examples of potential emission controls include selective catalytic reduction, more advanced fuel injectors, fuel/water emulsions, onboard water scrubbers, and cylinder lubricant control systems. This measure seeks to encourage or direct ship operators to either retrofit existing vessels or incorporate emission control devices into new build vessels. The measure could be an incentive program, a voluntary agreement, a regulation, or use some other mechanism.

Although this measure is currently designed to focus on PM and NOx emissions, it could be modified to also control GHG emissions. As a first step, the impact of the existing NOx and PM controls on GHG emissions should be evaluated. Next, additional opportunities to address GHG emissions would need to be investigated. Existing studies suggest a number of potential control measures that would reduce fuel consumption and therefore CO<sub>2</sub> emissions (as well as other pollutants). These measures include the incorporation of optimized hull and propeller designs in new ship builds, operational changes focused on fuel efficiency, new methods of hull maintenance to reduce fouling, and the use of wind, solar power, and fuel cells.

#### **4. Potential Emission Reductions**

As mentioned above, this measure is not currently designed to reduce GHG emissions, and the potential impact on GHG emissions has not been quantified. Staff believes that the impact will range from a slight increase to a slight reduction in GHG emissions.

#### **5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities**

TBD

#### **6. Technical Feasibility**

Improved engine design in new marine engine can improve combustion characteristics and reduce CO<sub>2</sub> emissions. However the impact of control measures to reduce PM, NOx, and SOx may increase CO<sub>2</sub> emissions.

#### **7. Additional Considerations**

See discussion under “**Staff Recommendation.**”

|                         |                            |
|-------------------------|----------------------------|
| <b>8. Division:</b>     | Stationary Source Division |
| <b>Staff Lead:</b>      | Paul Milkey                |
| <b>Section Manager:</b> | Peggy Taricco              |
| <b>Branch Chief:</b>    | Daniel Donohoue            |

# Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

## 1. Early Actions Strategy Name and Proponent

SUMMARY #            *B15*  
ID NUMBER:         *EJAC-16/ARB A-19*  
TITLE:                *ANTI-IDLING REQUIREMENT FOR CARGO HANDLING  
EQUIPMENT AT PORTS*  
PROPONENT:        *ENVIRONMENTAL JUSTICE ADVISORY COMMITTEE*

## 2. Staff Recommendation

This measure is recommended for evaluation in the Scoping Plan which will be developed as a draft by mid-2008 and must be considered by the Board prior to January 1, 2009. Evaluation as part of the Scoping Plan provides the most effective approach for fully considering the recommendation.

Staff believes significant informational gaps or constraints exist due to the dynamics of mobile cargo handling equipment operations, union labor contracts, and safety and security concerns, which prevent the implementation of an anti-idling requirement within the timeframe required for early action measures. The very nature of these operations makes it extremely difficult to determine what constitutes unnecessary idling. To illustrate, cargo handling equipment is often required to move rapidly from one location to another; and some equipment, such as rubber-tired gantry (RTG) cranes, have operator cabs approximately 50 feet above the ground, making it unsafe for the operator to exit the cab (i.e., idling limitations prevent air conditioner operation). It is inherently problematic and may complicate the development of idling restrictions at port terminals because they are generally larger than 200 acres and at any given time may have hundreds of pieces of equipment operating. All of these issues need further evaluation and many concerns need to be addressed.

In order to pursue this strategy, it would be necessary to collect complete equipment and facility specific operational data by facility type and/or operation. This data must be analyzed to identify similarities/dissimilarities in idling (equipment specific) at each facility and determine whether certain idling durations can be minimized and still not inhibit the functionality or efficiency of their operation. The next step would be to take this information and determine the extent to which cargo handling equipment engines idle, and what fraction of this total could be considered as unnecessary idling. Data logging would be the recommended method of collecting the various operational data needs. However, the variability in facility operations and the fact that the data must be equipment specific, taking into account the duty cycle of the engine, makes this a significant challenge, albeit achievable. While many data gaps prevent us from determining what is considered unnecessary idling at existing port or intermodal rail yard operations at this time, upcoming emission control retrofit demonstration programs for port equipment (such as top picks, side picks, RTG cranes, and reach stackers) include data logging components that will provide some data to help us evaluate this issue.

These efforts will be undertaken over the next two years and will help inform the decision on the appropriateness of pursuing an anti-idling measure.

### **3. Action Description**

This early action strategy proposes to adopt a statewide regulation to limit or prohibit unnecessary idling of mobile cargo handling equipment that operates at California ports or intermodal rail yards. The limiting or prohibiting of unnecessary idling will result in reduced fuel usage, fuel cost savings, and environmental/health benefits. A reduction in fuel consumption should result in greenhouse gas emission reductions, as well as, reductions of criteria or toxic air contaminants. However, the magnitude of these reductions is unquantifiable at this time due to lack of operational data. In the event it is determined feasible to establish restrictions on idling, the proposed strategy could be considered as amendments to the existing regulation for cargo handling equipment at ports and intermodal rail yards.

### **4. Potential Emission Reductions**

The potential greenhouse gas emission reduction potential of idling restrictions on cargo handling equipment cannot be quantified with any certainty at this time, but is anticipated to be low given the limited number of cargo handling equipment statewide.

### **5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities**

Information is not available to estimate costs or economic impacts of this proposed Early Actions Strategy. However, the sectors that may incur costs from a restriction on idling include engine manufacturers, distributors, dealers, facility owners or operators, shipping lines, industries that contract with the ports or intermodal rail yards for movement of goods, and ultimately the end-user of the applicable consumer products.

### **6. Technical Feasibility**

Limiting or prohibiting engine idling of mobile cargo handling equipment is likely to be technically feasible. However, the environmental benefits, cost effectiveness, emission reduction potential, and potential economic impacts on their operations can only be determined once more research and data collection has been completed and that data substantiates the extent to which unnecessary idling occurs. (See discussion under “**Staff Recommendation.**”)

### **7. Additional Considerations**

See discussion under “**Staff Recommendation.**”

|                         |                            |
|-------------------------|----------------------------|
| <b>8. Division:</b>     | Stationary Source Division |
| <b>Staff Lead:</b>      | Lisa Williams              |
| <b>Section Manager:</b> | Cherie Rainforth           |
| <b>Branch Chief:</b>    | Dan Donohoue               |

# Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

## 1. Early Actions Strategy Name and Proponent

SUMMARY #            *B16*  
ID NUMBER:         *EJAC-26/ARB A-17*  
TITLE:                *ELECTRIFICATION OF AIRPORT GROUND SUPPORT EQUIPMENT*  
PROPONENT:        *ENVIRONMENTAL JUSTICE ADVISORY COMMITTEE*

## 2. Staff Recommendation

This measure is recommended for evaluation in the Scoping Plan which will be developed as a draft by mid-2008 and must be considered by the Board prior to January 1, 2009. Evaluation as part of the Scoping Plan provides the most effective approach for fully considering this recommendation.

Those categories of ground support equipment (GSE) most amenable to being electric powered already have a high percentage of zero emission vehicles (ZEV). There may be some other categories of GSE that could be candidates for either ZEV technology or hybrid electric vehicle technology. Assessing feasibility for the early action timeframe can be addressed over the next year. The potential greenhouse gas emission reductions from this discrete strategy appear to be negligibly small because the number of affected vehicles is small.

## 3. Action Description

This Early Action Strategy proposes to accelerate the replacement of airport GSE by specifying electrification. The proponents of this measure did not provide any details on the dates for the accelerated electrification, the categories of GSE units specifically targeted, or the percentage of electrification required.

This measure would overlap with the implementation of two recently-adopted ARB regulations for off-road equipment that include GSE - large spark ignited (LSI) engines and in-use diesel equipment. The LSI regulation, that became effective May 12, 2007, incorporates requirements of the recently-terminated Memorandum of Understanding (MOU) with the airline industry that calls for 30% electrification of the airline-owned GSE fleet in the South Coast Air Basin by 2010. The LSI regulation applies to gasoline and liquid natural gas-powered GSE. On July 27, 2007, ARB adopted an in-use diesel off-road equipment regulation that requires diesel equipment fleet owners to reduce their fleet-average emissions of NOx and PM in future years by turnover of a specified percentage of their fleet horsepower. Until staff sorts through how this measure would mesh with these regulations, it is unclear how or if there would be conflicts between the measure and the regulations.

In addition to these two ARB regulations, the South Coast Air Quality Management District (District) has proposed a statewide measure for emission reductions from GSE in the South Coast Air Basin by requiring accelerated zero emission vehicle penetration and more stringent fleet-average emission standards for GSE. The District's proposed measure would require airlines in the South Coast to increase the percentage of ZEVs in their GSE fleets from 30% to 45% by 2014, an increase of 15% additional ZEV penetration.

#### **4. Potential Emission Reductions**

If the measure were to achieve an additional 15% electrification of the GSE fleet by 2014 as suggested by the SCAQMD, this measure would represent about 1,200 additional electric GSE units. The most likely categories of GSE that might be amenable for electrification include push back tractors and cargo loaders for which we have estimated energy requirements, fuel use, and electricity use for replacement ZEV units. Assuming that each diesel unit on average uses 2,800 gallons of diesel fuel per year (about 3.5 gallons per hour), this represents an emission reduction of 0.036 million metric tons per year of CO<sub>2</sub> emissions. Providing electricity from the California utility grid to recharge batteries for replacement ZEV units would require approximately 67 million kWh per year and would emit approximately 0.027 million metric tons of CO<sub>2</sub> annually, assuming each kilowatt-hour would require on average about 400 grams of CO<sub>2</sub> (Source: CEC). Thus, the net expected CO<sub>2</sub> emission benefit from this proposed measure would be on the order of 0.007 MMTCO<sub>2</sub>E per year.

#### **5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities**

If we assume that the Early Action Strategy would require an additional 15 % ZEV vehicles in the GSE fleets, the airlines could incur significant costs, since the requirement would mandate the early replacement of nearly 1,200 units by 2014. Assuming average unit costs for ZEV GSE equal to \$60,000, the total cost of the measure would be on the order of \$70 million. For units that reach the end of their lifetime during this period, there would be no lost revenue from early replacement, but for units that have to be retired early, there would be a revenue impact on airlines.

#### **6. Technical Feasibility**

Airlines have already undertaken substantial electrification of certain categories of the GSE fleet including baggage tractors and belt loaders representing an estimated 46% of the total statewide GSE fleet, mostly in the South Coast Air Basin and at Sacramento International Airport. Other categories of GSE that might be targets for electrification are pushback tractors and cargo loaders and cargo tractors, representing about 41% of the 200 GSE fleet. Pushback tractors represent almost 70% of the potential CO<sub>2</sub> emissions, while cargo loading and tractor equipment represents about 30% of potential CO<sub>2</sub> emissions. Electric pushback tractors are currently deployed in limited quantities in airline GSE fleets, while electric battery powered cargo loading equipment and cargo tractors have not yet been successfully demonstrated.

#### **7. Additional Considerations**

None.

**8. Division:** Planning and Technical Support Division  
**Staff Lead:** Jim Lerner  
**Section Manager:** Gary Honcoop  
**Branch Chief:** Kurt Karperos

**9. References:**

*New Emission Standards, Fleet Requirements, and Test Procedures for Forklifts and Other Industrial Equipment, ARB's LSI Regulation, effective May 12, 2007*

*Regulation for In-use Off-Road Diesel Vehicles, approved by ARB July 27, 2007*

*Final Air Quality Management Plan, approved by SCAQMD June, 2007, Off-Road Measure 04*

*California Electricity Consumption by County in 2005, CEC.*

*Inventory of California Greenhouse Gas Emissions and Sinks: 1990-2004, Final Staff Report, December 22, 2006, CEC.*

# Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

## 1. Early Actions Strategy Name and Proponent

SUMMARY #            *B17*  
ID NUMBER:         *EJAC-18*  
TITLE:                *ELECTRIFICATION OF CONSTRUCTION EQUIPMENT AT  
URBAN SITES*  
PROPONENT:        *ENVIRONMENTAL JUSTICE ADVISORY COMMITTEE*

## 2. Staff Recommendation

The ARB recently adopted an off-road diesel rule at its July 2007 Board hearing. This regulatory measure is believed to address the recommendations of the Environmental Justice Advisory Committee regarding the electrification of construction equipment at urban sites. That is because the measure requires or allows for the use of lower emission technologies including electrified equipment.

# Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

## 1. Early Actions Strategy Name and Proponent

SUMMARY #            *B18*  
ID NUMBER:         *EJAC-19*  
TITLE:                *HYBRIDIZATION OF MEDIUM- AND HEAVY-DUTY VEHICLES*  
PROPONENT:        *ENVIRONMENTAL JUSTICE ADVISORY COMMITTEE*

## 2. Staff Recommendation

This measure was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, no change in the classification of this measure is recommended. The Board date for consideration of this item is anticipated in 1<sup>ST</sup> quarter of 2011.

ARB staff was asked to investigate the feasibility of “hybrid electric technology for medium- and heavy-duty trucks” as an early action item to address greenhouse gas (GHG) emission reductions mandated by Assembly Bill 32. Medium duty trucks are trucks with gross vehicle weight rating (GVWR) between 8,501 and 14,000 pounds and heavy-duty trucks are 14,001 pounds and greater. Staff’s evaluation focuses on trucks with GVWR greater than 10,000 pounds, which hereinafter are referred to as heavy-duty trucks.

Despite the wide spread presence of hybrid electric technology in the passenger car industry, heavy-duty hybrid technology for commercial trucks are still in the pre-production development stage. The major factors hindering a rapid introduction of cost-effective hybrid technology in the heavy-duty vehicle sector are the high incremental cost and risk aversion by both hybrid builders and buyers.

Many of the present prototype heavy-duty hybrid vehicles use off-the-shelf components that are not designed and optimized for on-road heavy-duty hybrid vehicles. Some hybrid components are not commercially available and must be custom designed for the application. These components significantly increase the cost of the hybrid system due to the low production volumes. Also, reliability and maintainability of hybrid trucks are still being tested and long term durability of hybrid trucks has not been demonstrated for most applications.

Staff anticipates that hybrid technology will become available in the next 5 or more years as a commercial product for applications on urban delivery, utility, and other specialty work trucks with a potential to provide significant greenhouse gas emission reductions by 2020.

### 3. Early Action Description

Adopt a regulation and/or incentive program to take advantage of emerging hybrid electric technology for heavy-duty trucks.

Hybrid electric technology offers the potential to significantly improve fuel efficiency and performance while reducing emissions. However, these benefits are highly dependent on the duty cycle of the truck application. Hybrid technology provides the greatest benefit when used in vocational applications that have significant urban, stop-and-go driving, idling, and power take-off operations in their duty cycle. Such applications include parcel delivery trucks and vans, utility trucks, garbage trucks, transit buses, and other vocational work trucks. Line haul trucks are typically operated for long periods of time at high speed and load cruise driving modes and therefore, hybrid technology may not be as beneficial for this type of truck.

Several governmental and non-governmental organizations have been sponsoring research and developing programs that will bring together hybrid developers, truck and engine manufacturers, and truck users in an effort to speed up the introduction of heavy-duty hybrid technology into the marketplace.

Among the governmental organizations, the United States Department of Energy (DOE) has initiated a cost shared research and development program for advanced heavy-duty hybrid propulsion systems that will focus on improving fuel efficiency of heavy-duty trucks and buses. DOE is funding approximately \$4 million per fiscal year of cost shared projects with the heavy-duty hybrid industry (50/50 cost share) on this program<sup>1</sup>.

The United States Department of Transportation (DOT) in partnership with the North American Bus Industries, invested over \$50 million, in a program that demonstrated fuel efficiency improvements of a transit bus through hybrid propulsion and weight reduction using composite materials. In addition to investing in other hybrid and fuel cell demonstration programs, DOT also continues to fund the purchase of advanced hybrid electric transit buses<sup>1</sup>.

The United States Department of Defense is also a major sponsor in the development of heavy-duty hybrid technologies for combat vehicles and trucks.

The United States Environmental Protection Agency (U.S. EPA) has sponsored a program to develop and demonstrate the benefits of a hydraulic hybrid propulsion technology which is an alternative to hybrid electric propulsion. This system captures and stores a large portion of the braking energy by pumping hydraulic fluid into a high pressure hydraulic fluid accumulator and pressurizing an inert gas. The energy stored in the high pressure fluid is then used to help propel the vehicle during the next vehicle acceleration event<sup>2</sup>.

Among the non-governmental organizations are the WestStart-CALSTART operated Hybrid Truck Users Forum (HTUF) and the North West Hybrid Truck Consortium. HTUF assists truck users and hybrid truck makers to move to pre-production manufacturing levels and deployment and reduce overall costs by creating common fleet requirements and joint purchase commitments. Under the HTUF program, working groups that are currently active include the Parcel Delivery Working Group, the Utility Working Group, the Refuse Truck Working Group, and the Shuttle Bus Working Group<sup>3</sup>.

The Hybrid Parcel Delivery Truck Working Group focuses on Class 4 to 6 urban parcel delivery trucks and includes members from several major parcel delivery fleets in North America such as Federal Express (FedEx), United Parcel Service (UPS), Purolator Express, and the United States Postal Service (U.S. PS). FedEx was the first truck operator to test parcel hybrid electric trucks. It put 18 hybrid electric trucks on the road in 2005, 75 more in 2006 and is currently considering 75 more. Purolator Express has 10 hybrid electric parcel trucks and plans to add 115 trucks this year. UPS also plans to acquire 50 Eaton hydraulic hybrid trucks this year<sup>3</sup>.

The Hybrid Utility Working Group is made up of 14 fleets and focuses on Class 5 to 7 utility and specialty work trucks. The work group has deployed 24 utility trucks nationwide and preliminary results indicate fuel savings ranging between 10 to 50 percent<sup>3</sup>.

The Hybrid Refuse Working Group consists of 7 private and municipal refuse truck fleets. The purpose of this working group is to develop a common chassis and vehicle performance specifications in an effort to speed up the introduction of hybrid trucks for refuse fleet operations. In May 2007, the group released a request for proposals to purchase and deploy 8 preproduction hybrid refuse trucks for assessment<sup>3</sup>.

The Northwest Hybrid Truck Consortium is a coalition of several county and city governments, and utility companies located in the state of Washington. The group works together with HTUF to identify hybrid opportunities and raise regional and state funding for hybrid deployment. In 2006, the consortium acquired \$250,000 in funding from the U.S. EPA's West Coast Collaborative project, to support early hybrid truck deployments by reducing the incremental cost of the purchased hybrid trucks<sup>4</sup>.

#### 4. Potential Emission Reductions

To understand the potential of hybrid technology in reducing GHG emissions, staff estimated GHG emission reductions in 2020. Assuming that all new Class 3 to 5 (10,001 to 19,500 lbs) trucks sold in California beginning in 2015, use hybrid technology, the GHG emission reductions from these trucks are estimated to be 0.5 MMT of CO<sub>2</sub>e in 2020. These hybrid trucks represent 20 percent of the total California fleet in the same class and their vehicle miles traveled represents 30 percent of the total California fleet of the same class. To put this in perspective, if 100 percent of the Class 3 to 5 trucks were hybrids in 2020, the potential GHG emission reduction could be up to 1.7 MMT of CO<sub>2</sub>e.

**Table 1**

|   | CY 2020<br>(MY 2015-2020) | CY 2020<br>(ALL MYS) |   |
|---|---------------------------|----------------------|---|
| Vehicles<br>(10,001 to 19,500 lbs)                  | 53,421                    | 273,739              | - Fuel economy improvement: 35%<br>- Base truck fuel economy: 7.2 mpg |
| Daily Vehicle Miles<br>Travel                       | 3,694,200                 | 12,166,000           |   |
| GHGs Reduced in 2020<br>in MMT of CO <sub>2</sub> e | 0.5                       | 1.7                  |   |

## 5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

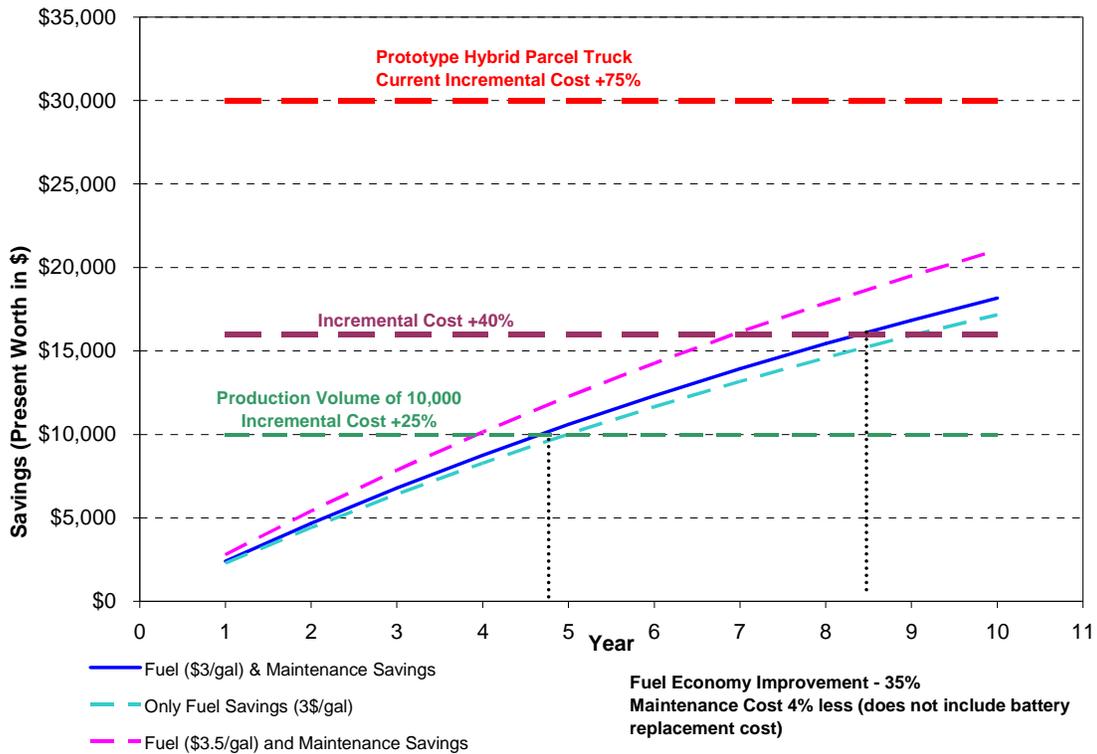
Table 2 compares a base truck with a “replacement” hybrid truck. As shown in the comments column of the table, the data were obtained from different sources. Incremental cost and in-use performance data were obtained from a hybrid truck builder and DOE published reports for hybrid buses and CNG trucks.

**Table 2**

|                                      | <b>Base Diesel Truck</b> | <b>Parcel Hybrid Truck</b> | <b>Comments</b>  |
|--------------------------------------|--------------------------|----------------------------|--|
| Cost (\$)                            | \$40,000                 | \$70,000                   | - Cost of the base truck is from a truck dealership.<br>- Incremental cost is from a hybrid builder: \$30,000 (75% above cost of base truck) for preproduction parcel trucks. (\$10,000, or 25% above cost of base truck for production volume of 10,000 trucks or more) |
| Fuel Economy (mpg)                   | 7                        | 9.5                        | Fuel economy improvement 35%<br>Base truck fuel economy is assumed to be 7 mpg.  |
| Fuel Cost (\$/gal)                   | \$3.00                   | \$3.00                     | In estimating fuel savings, the fuel price per gallon is assumed to remain constant during the 10 year lifetime period of the truck.   |
| Annual VMT (miles)                   | 22,000                   | 22,000                     | Source: Parcel delivery truck feet operator  |
| Life of the vehicle (years)          | 10                       | 10                         | Source: Parcel delivery truck feet operator  |
| Maintenance Cost                     | Unknown                  | Unknown                    | Being pre-production vehicles, the parcel fleet operator has not realized maintenance savings because of problems in software, transmission, parking brake, etc.   |
| Assumed maintenance costs: (\$/mile) | \$0.16                   | \$0.15                     | Base truck maintenance \$0.16/mi <sup>5</sup><br>Hybrid truck maintenance cost is assumed 4% less – considers only labor and parts cost without battery replacement <sup>6</sup>   |

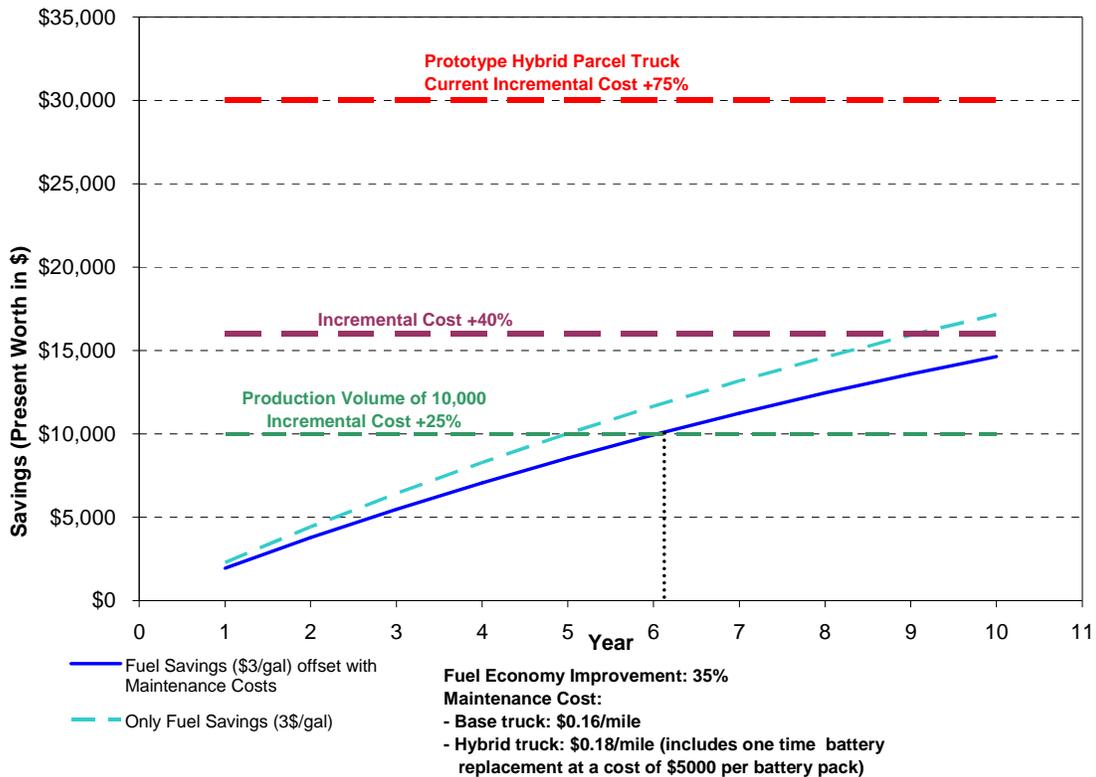
Figure 1 shows the savings realized from fuel economy improvements and reduced maintenance needs for the 10-year life of the parcel delivery truck. Future year savings were converted into 2007 dollars using a 7 percent discount rate. Assuming a 75 percent incremental cost difference, the chart shows that the preproduction hybrid parcel truck never recovers the incremental cost from fuel and maintenance savings. If production volume increases and the incremental cost drops to 25 percent of the cost of the base truck, then the hybrid truck will recover the incremental cost within 4 to 5 years. Note that in Figure 1 the maintenance cost for the hybrid truck is assumed to be 4% less than the base truck and does not include battery replacement.

Figure 1



According to one hybrid truck builder, the hybrid parcel delivery truck equipped with nickel metal hydride (NiMH) will require a one-time battery replacement during its life. The replacement battery pack costs between \$5,000 to \$8,000. Adding this cost to the maintenance cost of the hybrid truck results in \$0.18/mile which is 10 percent higher than that of the base truck. Figure 2, below, shows the savings and payback period for this truck. It can be seen that the payback period for the high volume production hybrid truck (incremental cost of 25 percent) becomes 6 years.

Figure 2



**6. Division:** Mobile Source Control Division  
**Staff Lead:** Daniel Hawelti  
**Section Manager:** Stephan Lemieux  
**Branch Chief:** Michael Carter

**7. References:**

<sup>1</sup> U.S. Department of Energy. "21<sup>st</sup> Century Truck Partnership: Roadmap and Technical White Papers", Report No.: 21CTP-0003. December 2006. ([http://www1.eere.energy.gov/vehiclesandfuels/pdfs/program/21ctp\\_roadmap\\_2007.pdf](http://www1.eere.energy.gov/vehiclesandfuels/pdfs/program/21ctp_roadmap_2007.pdf))

<sup>2</sup> U.S. Environmental Protection Agency. "World's First Full Hydraulic Hybrid in a Delivery Truck" EPA420-F-06-054, June 2006. (<http://www.epa.gov/otaq/technology/420f06054.pdf>)

<sup>3</sup> WestStart-CALSTART. "Hybrid Truck Users Forum". (website: <http://www.calstart.org/programs/htuf/>, accessed August 6, 2007)

<sup>4</sup> West Coast Collaborative. "Northwest Hybrid Truck Consortium" (website: <http://www.westcoastdiesel.org/grants/wa-hybrid-trucks.htm>, accessed: August 6, 2007)

<sup>5</sup> Chandler, K. and K. Walkowic. . "King County Metro Transit Hybrid Articulated Buses: Final Evaluation Results", U.S. DOE Technical Report: NREL/TP-540-40585. December 2006. ([http://www1.eere.energy.gov/vehiclesandfuels/avta/pdfs/heavy/king\\_co\\_final\\_12-06.pdf](http://www1.eere.energy.gov/vehiclesandfuels/avta/pdfs/heavy/king_co_final_12-06.pdf))

<sup>6</sup> Chandler, K., K. Walkowic, and Nigel Clark. "United Parcel Service (UPS) CNG Truck Fleet: Final Results", August, 2002. (<http://205.168.79.26/vehiclesandfuels/ngvtf/pdfs/31227.pdf>)

# Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

## 1. Early Actions Strategy Name and Proponent

SUMMARY #            *B19*  
ID NUMBER:         *EA B-1, B-2*  
TITLE:                *CEMENT (A): ENERGY EFFICIENCY OF CALIFORNIA CEMENT FACILITIES*  
PROPONENT:         *STAKEHOLDER SUGGESTION*

## 2. Staff Recommendation

This measure is recommended for addition to the list of early actions. The Board date for consideration of this item is anticipated in 4<sup>th</sup> quarter of 2010

Staff assessment indicates that significant near term carbon dioxide (CO<sub>2</sub>) reductions might be obtained by implementing energy efficient practices and technologies at California's cement facilities.

A proposed measure to consider greater reduction from low-carbon fuels in the cement sector is recommended for evaluation in the Scoping Plan which will be developed as a draft by mid-2008 and must be considered by the Board prior to January 1, 2009. Evaluation as part of the Scoping Plan provides the most effective approach for fully considering the recommendation, which could entail large cost impacts on cement production in California.

## 3. Early Action Description

California's eleven cement facilities manufacture between 10 to 15 percent of the United States cement production. Annually, these eleven facilities use large amounts of energy: 1440 gigawatt hours (GWh) of electricity (7.2% of total energy used), 17.6 million therms of natural gas (2.6%), 2.3 million tons of coal (87.9%), 0.25 tons of coke (<0.1%), and burns 5.9 million tires<sup>1</sup> (2.3%). The three sources that result in CO<sub>2</sub> emissions from cement facilities are: 1) direct emissions from fuel combustion, 2) direct emissions from limestone calcination, and 3) indirect emissions from electricity use. Reducing CO<sub>2</sub> emissions from fuel combustion, calcination, and electricity use requires facilities to convert to using a low-carbon fuel, decrease fuel consumption, and improve energy efficiency practices and technologies in cement production<sup>2</sup>.

## 4. Potential Emission Reductions

In 2004, CO<sub>2</sub> emissions from fuel combustion, limestone calcination, and electricity use are estimated at 10.8 million metric tons of CO<sub>2</sub> equivalent per year (MMTCO<sub>2</sub>E). Staff estimates that CO<sub>2</sub> emissions from fuel combustion are 4.1 MMTCO<sub>2</sub>E, limestone calcination 5.9 MMTCO<sub>2</sub>E, and electricity use at 0.8 MMTCO<sub>2</sub>E.

Potential carbon dioxide reductions are estimated for all three of those categories listed below:

A. Fuel Combustion

Clinker production is the most energy-intensive stage in cement production, accounting for over 90% of total industry energy use<sup>3</sup>. The most prominent fuel source used for clinker production in California is coal. Coal accounts for over 95% of all CO<sub>2</sub> emissions from fuel consumption. Coal emits over 210 pounds of CO<sub>2</sub> per million Btu (MBtu) compared to 117 pounds of CO<sub>2</sub> per MBtu of natural gas<sup>4, 5</sup>. If a low-carbon fuel, such as natural gas, is substituted for coal, potential reductions could exceed 1 MMTCO<sub>2</sub> reduction per year can be obtained. Further evaluation and information is needed to determine the feasibility of this proposed measure. Issues such as cost, infrastructure, plant modifications, and operational requirements need to be evaluated in more detail to determine if switching to low-carbon fuels can be recommended as a strategy for reducing greenhouse gas emissions.

B. Energy-efficiency Practices and Technologies

Energy-efficiency practices and technologies in cement production can be implemented to decrease CO<sub>2</sub> emissions. Energy consumption in the cement plant sector consists of energy used for raw material preparation, clinker production and finish grinding<sup>6</sup>. Raw material preparation and finish grinding is an electricity-intensive (indirect emissions) production. However, electricity accounts for only 10% of the overall energy use at cement plants<sup>7</sup>.

1. Raw Materials Preparation

The standard raw materials used in California for cement production are limestone, chalk, and clay. These materials are usually extracted from a quarry close to the plant. Approximately 1.5 tons of raw materials are required to produce one ton of Portland cement. Raw materials preparation involves transport systems, blending, grinding mills, and classifiers (separators). Using the most highly efficient equipment in this category can save electricity and reduce indirect CO<sub>2</sub> emissions by 0.2 MMTCO<sub>2</sub>E at power plants.

2. Clinker Production

The heating of cement kilns to produce clinker is the largest user of energy at these facilities. To improve the energy-efficiency in clinker production, improved control systems, improved combustion system, reduction in kiln heat loss, grate coolers, preheater/precalciner type systems, newer mill drives, and use of secondary fuels can be utilized. Staff lacks sufficient data to estimate potential CO<sub>2</sub> reductions from California facilities. Much of the information available is based on national averages of cement plant efficiencies. Using this data, potential energy efficiency improvements could result in up to 0.7 MMTCO<sub>2</sub>E annually. Staff believes this estimate overstates the potential CO<sub>2</sub> reductions because a study by Lawrence Berkeley National Lab<sup>8</sup> found that California plants operate more efficiently than the national average. In order to more accurately assess potential reductions, staff needs to obtain plant specific information from each California facility.

### 3. Finish Grinding

To produce powdered cement, clinker is ground to the consistency of face powder. Finish grinding involves process control, grinding mills, and classifiers. Carbon dioxide emissions reduction of 0.1 MMTCO<sub>2</sub>E can be accomplished with high-efficiency equipment.

## 5. Estimated Costs/Economic Impacts and the Impacted Sectors/Entities

The estimated cost impact to California's cement industry to use cleaner fuels and more energy-efficient equipment/technologies is about one billion dollars annually. These costs are discussed below.

Coal is the major fuel used in California to heat the kiln used in clinker production. If coal was replaced by natural gas, total annual cost increase for California facilities would be estimated at \$500 million. This equates to approximately \$200 per metric ton of carbon dioxide equivalent (MTCO<sub>2</sub>E) reduced per year. It should be noted that this number only reflects the difference in fuel costs. Additional work is needed to determine infrastructure and other costs that may significantly change the cost effectiveness.

Several technologies and practices exist that can reduce the energy intensity of various process stages of cement production. If each cement facility changed to higher energy-efficiency equipment for raw material preparation, the total cost is estimated at \$258 million. This corresponds to approximately \$1,300 per MTCO<sub>2</sub>E reduced. The finish grinding process is estimated at \$111 million if all cement facilities changed equipment for higher energy-efficiency. This equates to \$1,100 per MTCO<sub>2</sub>E reduced. Finally, improved energy-efficiency for clinker production involves many technical stages. Total cost for modification is estimated at \$90 million. This corresponds to \$125 per MTCO<sub>2</sub>E reduced. Additional information is necessary to more accurately determine energy efficiency strategies.

## 6. Technical Feasibility

This measure is technically feasible by applying low-carbon fuels for heating cement kilns and using more efficient equipment at various process stages of cement production. However, staff lacks information regarding the actual benefits that would be achieved by replacing existing equipment with more energy efficient equipment used at each California cement facility. Administering these measures could be costly to industry.

## 7. Additional Considerations

- Applicability of technological changes will depend on the current and future situations regarding individual plants. Capital projects would be implemented only if the company has more than 50 years of limestone reserve remaining. Cement plants with a shorter supply would most likely implement minor upgrades and focus on energy management measures.

- Mercury emissions from coal and raw materials needs to be evaluated. An assessment needs to be implemented concurrently with greenhouse gas reduction strategies to better understand impacts to industry.

**8. Division:** Stationary Source  
**Staff Lead:** Jim Stebbins  
**Section Manager:** Todd Wong  
**Branch Chief:** Michael Tollstrup

## 9. References

<sup>1</sup> Coito F, Friedmann R, Powell F, Price L, and Worrell E. 2005. *Case Study of the California Cement Industry*. Ernest Orlando Lawrence Berkeley National Laboratory, LBNL-59938

<sup>2</sup> Martin N, Worrell E, and Price L. 1999. *Energy Efficiency and Carbon Dioxide Emissions Reduction Opportunities in the U.S. Cement Industry*. Ernest Orlando Lawrence Berkeley National Laboratory, LBNL-44182

<sup>3</sup> Ruth M, Worrell E, Price L. 2000. *Evaluating Clean Development Mechanism Projects in the Cement Industry Using a Process-Step Benchmarking Approach*. Ernest Orlando Lawrence Berkeley National Laboratory, LBNL-45346

<sup>4</sup> ICF Consulting. 1999. *Emissions Factors, Global Warming Potentials, Unit Conversions, Emissions, and Related Facts*.  
 Website: <http://www.p2pays.org/ref/07/06861.pdf>

<sup>5</sup> Leonardo Academy, Inc. – *Multiple Pollutant Emission Reduction Reporting System (MPERRS)*. 2007. *Emission Factors and Energy Prices for Leonardo Academy's Cleaner and Greener Program*.  
 Website: <http://www.cleanerandgreener.org/download/efactors.pdf>

<sup>6</sup> Worrell E and Galitsky C. 2004. *Energy Efficiency Improvement Opportunities for Cement Making – An Energy Star Guide for Energy and Plant Managers*. Ernest Orlando Lawrence Berkeley National Laboratory, LBNL-54036

<sup>7</sup> Van Oss HG. 2005. *Background Facts and Issues Concerning Cement and Cement Data*. United States Geological Survey. Open-file Report 2005-1152

<sup>8</sup> Masanet E, Price L, de la Rue du Can S, and Brown R. 2005. *Optimization of Product Life Cycles to Reduce Greenhouse Gas Emissions in California*. Lawrence Berkeley National Laboratory for the California Energy Commission. CEC-500-2005-110-F.

# Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

## 1. Early Actions Strategy Name and Proponent

SUMMARY #            *B20*  
ID NUMBER:         *EA B-1, B-2*  
TITLE:                *CEMENT (B): BLENDED CEMENTS*  
PROONENT:         *ENVIRONMENTAL JUSTICE ADVISORY COMMITTEE*

## 2. Staff Recommendation

This measure is recommended for addition to the list of early actions. The Board date for consideration of this item is anticipated in 2<sup>nd</sup> quarter of 2009.

## 3. Early Action Description

From cement plants, carbon dioxide (CO<sub>2</sub>) emissions are released into the atmosphere during the calcination process and the burning of fuels to produce clinker, the main ingredient in Portland Cement. The calcination process involves the decomposition of calcium carbonate (limestone) to calcium oxide (clinker or lime), in which CO<sub>2</sub> is released. Calcination is carried out in furnaces or kilns under very high temperatures.

A strategy to reduce CO<sub>2</sub> emissions involves the addition of blending materials such as limestone, fly ash, natural pozzolan and/or slag to replace some of the clinker in the production of Portland Cement. Currently, ASTM cement specifications allow for replacement of up to 5% clinker with limestone. Most manufacturers could in fact replace up to 4% with limestone. Caltrans allows for 2.5% average limestone replacement until testing of the long term performance of the concrete is complete. Caltrans currently has over \$1 million in task orders and is devoting considerable staff resources to the evaluation of limestone blending in cement. Caltrans also currently has standards for using flyash and slag in concrete. Other blending practices will be explored.

Industrial wastes such as coal fly ash, blast furnace slag, and silica fume have cementitious properties and can be blended with clinker or added at the concrete mixing stage. The quality of these blended cements is comparable to Portland cement. The differences are lower initial strength, but higher final strength, and improved resistance to sulfates and seawater. In the United States, one study estimated that these blended cements account for about one percent of the domestic cement shipments. Limitations on further penetration of fly ash, slag, and silica fume into the concrete market depends on the availability, construction standards, transportation costs, and user preferences; however, the potential CO<sub>2</sub> emission reduction potential warrants further examination. Caltrans mandates 25% fly ash in almost all of its concrete and allows up to 35% fly ash replacement of cement. Caltrans also allows up to 60% slag replacement of cement in all concrete. Additional staff work is needed to determine other current blending practices in the State.

#### **4. Potential Emission Reductions**

In 2004, cement plants in California produced about 11.2 million metric (MM) tons of clinker, which corresponds to about 10.8 MM tons of CO<sub>2</sub> emitted from the production of clinker. Blending with 25% fly ash, slag, or silica fume has a potential to reduce CO<sub>2</sub> emissions by reducing the need to produce an equivalent amount of clinker. For each percent of cement replaced by these blending materials, CO<sub>2</sub> emissions may be reduced proportionally. At this time, ARB staff does not have information on how much of blended cements are used in California and further evaluations are needed to estimate the potential use of these blended cements to reduce CO<sub>2</sub> emissions. It should be noted that this strategy may not reduce CO<sub>2</sub> emissions in California, but is expected that cement imports would be reduced and thus result in reduced emissions elsewhere.

Fly ash that is typically blended is a by-product of coal combustion and may contain mercury. Mercury levels in fly ash need to be evaluated.

#### **5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities**

The production of clinker is an energy intensive process, which involves heating and maintaining high temperatures in the cement kilns and its associated equipment (pre-heaters/pre-calciners). This strategy may result in the production of less clinker per unit of cement produced. In blending with 5% limestone, it is estimated that clinker production could be reduced by 0.56 MM tons, resulting in a reduction in energy use of  $2.14 \times 10^6$  MMBtu. This is equivalent to not burning 75,000 tons of coal and saving plant operators in the State about \$3 million. Due to the lack of information, the economic impacts of blending 25% fly ash or slag can not be determined at this time.

#### **6. Technical Feasibility**

The replacement of Portland Cement with limestone is technically feasible and may reduce CO<sub>2</sub> emissions per unit of cement produced. However, additional evaluations are warranted to assess the feasibility, availability, and cost of blended cements containing fly ash and slag.

#### **7. Additional Considerations**

- The cement plant industry and environmental groups support the use of blending cements.
- The production of clinker at cement plants is also a source of mercury emissions caused by naturally occurring mercury found in the raw materials and from the combustion of coal. ARB staff has begun its efforts to understand the processes involved with the production of Portland cement, gather information to assess the impacts of both CO<sub>2</sub> and mercury emissions, evaluate control options for all pollutants, and assess the economic impacts to the industry and the public. It is not yet fully understood the potential impacts of blending on mercury emissions from cement manufacturing facilities.
- Ongoing and future discussions with Caltrans and other agencies will ensure that

the addition of blended cements will meet their specifications and approval.

- Additional work is needed is needed to determine the extent to which blending currently is being done and the technical feasibility of establishing limits for the blending of fly ash and slag as a strategy to reduce CO2 emissions.

**8. Division:** Stationary Source Division  
**Staff Lead:** Duc Tran  
**Section Manager:** Todd Wong  
**Branch Chief:** Michael Tollstrup

## 9. References

*Van Oss HG. 2005. Background Facts and Issues Concerning Cement and Cement Data. United States Geological Survey. Open-file Report 2005-1152.*

*Website: <http://www.ket.org/Trips/Coal/AGSMM/agsmmmtypes.html>*

*U.S Cement Plant Detail by State, PCA, December 31, 2004*

*Lisa J. Hanle, CO<sub>2</sub> Emission Profile of the U.S Cement Industry, U.S. Environmental Protection Agency.*

*Kamala R. Jayaraman and Joshua S. Smith, ICF Consulting*

*PCA, Cement Kiln Dust Production Summary for California Portland Cement Plants.*

*Peter Hawkins, Paul Tennis, and Rachel Detwiler, The Use of Limestone in Portland Cement: A state-of-the-Art Review, PCA.*

*Climate Action Program at Caltrans, California Department of Transportation, December 2006.*

*Using Coal Ash in Highway Construction: A Guide to Benefits and Impacts*

*Website: <http://www.epa.gov/epaoswer/osw/conserves/c2p2/pubs/greenbk508.pdf>*

*Joe Seay, HeadWaters, Incorporated, August 2, 2007, Personal Communication.*

*Pam Herman Milmoie and Martin Ross, United States Environmental Protection Agency, Evaluation of the Environmental Impacts from APCA/CW Partnership, presented at the 1999 American Council for an Energy Efficient Economy (ACEEE)*

# Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

## 1. Early Actions Strategy Name and Proponent

SUMMARY #            *B21*  
ID NUMBER:         *EJAC-22*  
TITLE:                *RELATIVELY INEXPENSIVE ENERGY SAVINGS MEASURES  
WITH SHORT PAY BACK TIMES FOR FOSSIL FUEL POWER  
PLANTS BUILT PRIOR TO 1980*  
PROPONENT:        *ENVIRONMENTAL JUSTICE ADVISORY COMMITTEE*

## 2. Staff Recommendation

This measure is recommended for evaluation in the Scoping Plan which will be developed as a draft by mid- 2008 and must be considered by the Board prior to January 1, 2009. Evaluation as part of the Scoping Plan provides the most effective approach for fully considering the recommendation.

In addition, the ARB staff recommends working with the local air districts to start a dialogue with power plant owners and operators to disseminate information on energy savings measures through an educational outreach program. For these measures, there is already inherent built-in advantages (cost savings and short payback times).

## 3. Early Action Description

This strategy proposes that the ARB implement relatively inexpensive energy savings measures with short payback times for fossil fuel-fired power plants constructed prior to 1980. The EJAC has identified these older electrical generating units as significant contributors to greenhouse gas emissions due to their lower thermoelectric efficiencies compared to new state-of-the-art combined-cycle power plants.

ARB staff determined that there are 59 fossil fuel-fired thermoelectric power plants within California that came online prior to 1980. In 2005, the CO<sub>2</sub> emissions from these facilities totaled 13.9 million metric tons of CO<sub>2</sub>-equivalent per year (MMTCO<sub>2</sub>E) or about 25 percent of total CO<sub>2</sub> emissions from all power plants in California.

ARB staff has identified two potential measures that could generate energy savings with minimal investment. The U.S. Department of Energy's (DOE) Industrial Technologies Program helps industrial plants operate more efficiently and profitably by identifying ways to reduce energy use in key process systems. The program has identified that minimal improvements in burner efficiency can result in significant savings. The following case from the DOE website ([www.eere.energy.gov/industry](http://www.eere.energy.gov/industry)) provides an example of the potential savings:

Case: Consider a 50,000 lb/hr process boiler with a combustion efficiency of 79% (E1). The boiler annually consumes 500,000 million Btu (MMBtu) of natural gas. At a price of \$8.00/MMBtu, the annual fuel cost is \$4 million. The installed cost is

\$75,000 for a new burner that provides an efficiency improvement of 2% (E2).  
The cost savings is:

$$\begin{aligned} \text{Cost Savings} &= \text{Fuel Consumption} \times \text{Fuel Price} \times (1 - E1/E2) \\ &= 500,000 \text{ MMBtu/year} \times \$8/\text{MMBtu} \times (1 - 0.79/0.81) \\ &= \$98,760/\text{year} \end{aligned}$$

The simple payback on investment is:  
Simple Payback = \$75,000 / \$98,760/year = 0.76 year

The table below shows the annual dollar savings for 1% and 3% efficiency improvements.

| Burner Combustion Efficiency Improvement | Annual Energy Savings (MMBtu/year) | Annual Dollar Savings |
|--|------------------------------------|-----------------------|
| 1%                                       | 6,250                              | \$50,000              |
| 2%                                       | 12,345                             | \$98,760              |
| 3%                                       | 18,290                             | \$146,320             |

The second measure is the use of newly-developed “automated migration tools,” which consist of control and process optimization software to enhance operations by automatically balancing the process for optimum results, coordinating boiler/turbine control, emissions monitoring, economic dispatch, and fleet management. (Westinghouse Process Control, Inc., a subsidiary of Emerson, is one such vendor of this technology.) Some of the benefits include lower maintenance and materials costs, improvements in heat rate, and reductions in unit startup time. The software allows power plants to modernize their operations for greater efficiency and output, while at the same time minimizing their generation downtime.

These efficiency-enhancing measures may be of particular interest to the coastal power plants that have once-through cooling. Once-through cooling is an effective and relatively inexpensive method for re-condensing super-heated steam after it has been used to generate power. Once-through cooling draws sea water into the plant, where it flows through a heat exchanger to cool the steam, and then subsequently returns the heated water back into the environment. Sea water is abundant and cold and represents an efficient means of handling waste heat. However, once-through cooling may have a deleterious environmental impact due to the entrainment and impingement of marine life; therefore, the State Water Resources Control Board is currently developing a statewide policy to implement federal Clean Water Act requirements for power plants that utilize once-through cooling. If a less-efficient cooling method is required by these power plants, they could suffer an energy penalty ranging from 1.7 to 8.6 percent. ARB staff has identified 17 pre-1980 plants that may need to be retrofitted to comply with proposed once-through cooling requirements. Measures to mitigate this loss in overall efficiency may be especially pertinent.

#### 4. Potential Emission Reductions

For the example case above for a single boiler, the potential emission reductions range from 0.12 to 0.34 MMTCO<sub>2</sub>E based on the fuel savings from the burner efficiency improvements. A plant-by-plant analysis is required to determine how many generating

units in the State have not already gone through similar modifications and could benefit from this measure. In addition, ARB staff was not able to obtain information on specific efficiency rates associated with the optimization software. Further investigation is required. Therefore, ARB staff cannot yet determine the total emission reduction potential of this strategy. However, depending on annual fuel consumption rates for the 59 pre-1980 power plants and opportunities for at least one percent efficiency improvements, there is a potential for significant emission reduction.

A potential co-benefit of efficiency improvements that lower overall fuel use is a concurrent reduction in criteria pollutant emissions.

## **5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities**

The cost of burner improvements will be site-specific. Also, ARB staff was not able to obtain information on upgrade costs associated with the optimization software, and further research is required. Therefore, the total cost of implementation cannot yet be determined due to the need to assess each generating unit on a case-by-case basis. Costs will be borne by the power plants, but the payback in efficiency and reduced fuel consumption should provide a short payback time and would not be expected to translate into increased electricity rates for consumers.

## **6. Technical Feasibility**

In 2006, the DOE's Industrial Technologies Program completed 200 Energy Savings Assessments at U.S. industrial plants. Their website contains over 50 case studies for companies that have participated in past assessments and that are already saving energy and money. These studies describe demonstrated energy improvement projects, process improvement projects, and/or assessments at the plant level. These projects and accompanying savings can be replicated at similar plants.

With respect to optimization software, Westinghouse Process Control's website ([www.emersonprocess-powerwater.com/solutions/pwr-successstories.cfm](http://www.emersonprocess-powerwater.com/solutions/pwr-successstories.cfm)) describes experience with over 30 power generation projects across the U.S. and internationally.

## **7. Additional Considerations**

- This measure would complement other actions taken by State agencies. In September 2005, the California Public Utilities Commission (CPUC) launched an ambitious energy efficiency and conservation campaign by authorizing energy efficiency plans and \$2 billion in funding for 2006-2008 for the State's utilities.
- In addition, this item may be included under two CAT strategies to be implemented by the California Public Utilities Commission—specifically, “Investor Owned Utility Energy Efficiency Programs (including LSEs)” and “Investor-Owned Utility (IOU) Additional Energy Efficiency Programs/Demand Response.”

Before taking this item to the Board, ARB staff recommends conducting further research to identify any additional low-cost energy savings opportunities for power plants and to

obtain a more accurate quantification of the potential emission reductions based on a case-by-case analysis of options.

**8. Division:** Stationary Source Division  
**Staff Lead:** Chris Gallenstein  
**Section Manager:** Mike Waugh  
**Branch Chief:** Mike Tollstrup

## 9. References:

*California Air Resources Board, database on California power plants, based on air district permit information from 2001.*

<sup>2</sup> *California Air Resources Board, spreadsheet on greenhouse gas emissions from power plants for 2005, based on Energy Information Administration data.*

<sup>3</sup> *California Energy Commission, "Integrated Energy Policy Report," Appendix A: Aging Power Plant Study Group, publication #CEC-100-2005-1007-CMF, November 2005.*

<sup>4</sup> *California Energy Commission, "Inventory of California Greenhouse Gas Emissions and Sinks 1990 to 2004," Staff Final Report, publication #CEC-600-2006-013-SF, December 2006.*

<sup>5</sup> *California Energy Commission, "Status and Known Plans of Coastal Plants using OTC," April 2007.*

<sup>6</sup> *California Energy Commission, spreadsheet on pre-1980 generating unit ratings and status.*

<sup>7</sup> *California Public Utilities Commission, "PUC's Energy Leadership," January 2007: [http://www.cpuc.ca.gov/static/070319\\_revenergystory0107.pdf](http://www.cpuc.ca.gov/static/070319_revenergystory0107.pdf)*

<sup>8</sup> *Emerson Process Management's Power Success Stories, April 9, 2001: [http://www.emersonprocess.com/solutions/power/success\\_story\\_1.asp](http://www.emersonprocess.com/solutions/power/success_story_1.asp)*

<sup>9</sup> *U.S. Department of Energy, Industrial Technologies Program, Energy Efficiency and Renewable Energy, Steam Tip Sheet #24, DOE/GO-102006-2269, January 2006.*

# Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

## 1. Early Actions Strategy Name and Proponent

SUMMARY #            *B22*  
ID NUMBER:         *EJAC-23/EJAC-29/ EJAC-31*  
TITLE:                *IDENTIFY AND IMPLEMENT ENERGY EFFICIENCY MEASURES AT REFINERS THAT INCLUDE, BUT ARE NOT LIMITED TO, CONDUCTING AN ENERGY AUDIT*  
PROPONENT:        *ENVIRONMENTAL JUSTICE ADVISORY COMMITTEE*

## 2. Staff Recommendation

This measure is recommended for evaluation in the Scoping Plan which will be developed as a draft by mid-2008 and must be considered by the Board prior to January 1, 2009. Evaluation as part of the Scoping Plan provides the most effective approach for fully considering the recommendation.

Several of the measures that could be implemented to realize energy efficiency savings with potential greenhouse gas (GHG) benefits are listed in the section(s) below. Staff reviewed specifics of the necessary steps/processes necessary to implement such actions. This includes permitting and construction activities. Staff has concluded that all these measures could potentially provide moderate to significant GHG benefits. However, given the remaining uncertainties with identifying a viable strategy, staff does not recommend adding the suggested measures to the list of early actions. As part of its ongoing assessments, staff plans to:

- a) Perform an evaluation to determine refiner's energy use and energy efficiency.
- b) Develop a detailed strategy to define a plan to monitor changes in refinery energy uses and efficiency over time.
- c) Define regulatory measures that could be implemented.

Each of these activities requires detailed analyses to ensure a comprehensive plan is adopted by each refinery before energy efficiency measures could be implemented.

## 3. Early Action Description

U.S. Department of Energy, the American Petroleum Institute, and large refinery facilities have completed a number of energy efficiency projects and demonstration studies in the last ten years. The results from these activities are the basis of the suggested measures for energy efficiency savings. The potential measures that could achieve modest to significant energy savings include: use of an energy management assessment system to continually optimize refinery processes, installation of new or expanding existing co-generating capacity, use of new (low-energy) technologies for desulfurization of fuels, incorporating low level heat streams back into refinery processes, reducing fouling and corrosion in cooling water streams, and treating and using low BTU refinery plant gas as an energy source. Some of these measures are currently under evaluation by refiners.

#### **4. Potential Emission Reductions**

Current ARB GHG combustion estimates suggest that California refineries emit 30 million metric ton equivalents of CO<sub>2</sub> annually. However, energy and GHG savings need to be determined for each refinery. Co-generation reduces CO<sub>2</sub> emissions by ~ 25% (not plant wide but just from this source of energy) compared to steam and electricity being delivered by an external utility. Savings are mainly derived by lower transmission losses, export of electricity and better heat management at the facility. The other measures when implemented could provide for marginal to moderate reductions (< 10%) reductions in energy needs for a given refinery with attendant GHG reductions.

#### **5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities**

All the measures indicated above have moderate to significant costs associated with planning, design, permitting, construction and maintenance. Most if not all costs associated with implementation would be the responsibility of the refinery.

#### **6. Technical Feasibility**

Most of the proposed measures have been demonstrated to be feasible and cost effective by industry and government agency projects. However, refinery specific technical feasibility analyses need to be conducted to ensure that the specifics of each refinery are considered before adopting or mandating any energy efficiency measure.

#### **7. Additional Considerations**

Significant technical challenges exist to adapting findings from energy assessments of even a small refinery. Completing such assessments could take anywhere from 12-18 months before a report could be delivered. Based on the recommendation, construction, permitting, etc. may require additional time. Hence, adoption of measures to conduct such energy assessments is reasonable but not as discrete early action measures due to the time needed to conduct a complete assessment.

A study conducted by the California Energy Commission in participation with California refiners concluded that implementation would entail time frames of 3 or more years even for measures for which there was no significant technical, regulatory, enforcement, or other challenges. This conclusion is similar to staff's assessment of timelines necessary for adoption of any of the measures discussed above.

**8. Division:** Stationary Source  
**Staff Lead:** Reza Lorestany  
**Section Manager:** John Courtis  
**Branch Chief:** Dean Simeroth

# Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

## 1. Early Actions Strategy Name and Proponent

SUMMARY #            *B23*  
ID NUMBER:         *EJAC-24*  
TITLE:                *ACCELERATE THE REPLACEMENT OF CARGO HANDLING EQUIPMENT AT PORTS*  
PROPONENT:        *ENVIRONMENTAL JUSTICE ADVISORY COMMITTEE*

## 2. Staff Recommendation

This measure is recommended for evaluation in the Scoping Plan which will be developed as a draft by mid-2008 and must be considered by the Board prior to January 1, 2009. Evaluation as part of the Scoping Plan provides the most effective approach for fully considering the recommendation.

Accelerating the replacement of cargo handling equipment at ports and intermodal railyards beyond that required by the Air Resources Board's (ARB) regulation for Mobile Cargo Handling Equipment at Ports and Intermodal Rail Yards (Cargo Handling Rule) could compromise the expected reductions in NO<sub>x</sub> and diesel PM from that rule and would have negligible impacts on greenhouse gas emissions. Accelerating the implementation dates for compliance could potentially jeopardize the overall benefits that can be realized from the Cargo Handling Rule. While there may be some near-term increase in emission reductions, a large portion of the overall benefits that are scheduled to be realized would be lost since operators would not be able to purchase the cleaner Tier 4 engines that will be available in the post 2011 timeframe. For example, for some larger equipment, such as rubber tire gantry cranes (RTG) that have long useful lives (up to 20 years or more), high horsepower ratings, and are costly (upwards of over 1 million dollars), the regulation was designed to accelerate the turnover of this equipment such that, in most cases, a new RTG would be purchased when the ultra-low emission Tier 4 engines would be available. Having this equipment replaced sooner, as proposed in this early action measure, would result in the loss of the significant emissions benefits from a Tier 4 engine since the operator would have to purchase either a Tier 2 or Tier 3 engine. Since this equipment has a long useful life, the benefits of a Tier 4 engine would be foregone for up to 20 years.

Furthermore, it is expected that the Cargo Handling Rule, or the acceleration of that rule, would result in a negligible effect on global warming. Because the Cargo Handling Rule requires operators to move from uncontrolled engines to cleaner engines with NO<sub>x</sub> and PM controls and in some cases to apply exhaust retrofits, there can be a fuel economy penalty as high as two to four percent. When more fuel is burned, more CO<sub>2</sub> is produced, and CO<sub>2</sub> is a greenhouse gas. However, the Cargo Handling Rule does result in the reduction of black carbon emissions which also contribute to global warming and this may offset the fuel penalty effects.

Accelerating the turnover would result in the loss of NO<sub>x</sub> and diesel PM emission reductions over the life of the equipment resulting in a loss of public health protection and without achieving any measurable greenhouse gas benefits.

### **3. Early Action Description**

The Cargo Handling Rule became effective December 6, 2006, and established performance standards based on the best available control technology (BACT) for new and in-use cargo handling equipment operating at these facilities. Compliance with the regulation will be phased in beginning in 2007 based on the age of the engine, whether or not it is a yard truck or non-yard truck equipment, and the size of the fleets. The performance standards and compliance dates in the regulation were designed to maximize the public health benefits from the rule, taking into account the useful life of the equipment, the use and cost of new equipment, the horsepower of the engines, and when cleaner new engines, in particular the 2007 on-road engines and Tier 4 off-road engines, would be available.

This Early Action Strategy proposes to accelerate the replacement of cargo handling equipment at ports and intermodal rail yards earlier than the compliance schedules required by the existing statewide regulation for Mobile Cargo Handling Equipment at Ports and Intermodal Rail Yards. The proponents of this measure did not provide any details on the dates for acceleration or the equipment targeted.

### **4. Potential Emission Reductions**

As discussed under “**Staff Recommendation**”, we do not expect any greenhouse gas emission benefits from this proposed early action measure.

### **5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities**

The costs associated with accelerating the implementation dates in the Cargo Handling Rule could be significant. In most cases, the useful life of equipment would be decreased even more than required by the rule, resulting in increased costs to terminal operators, shippers, and consumers.

### **6. Technical Feasibility**

It is technically feasible to require faster turnover of equipment at ports and intermodal rail yards. However, as discussed in “**Staff Recommendation**,” accelerating the turnover would decrease the expected emission reductions of NO<sub>x</sub> and diesel PM from the rule and have negligible impacts on greenhouse gas emissions.

### **7. Additional Considerations**

|                         |                            |
|-------------------------|----------------------------|
| <b>8. Division:</b>     | Stationary Source Division |
| <b>Staff Lead:</b>      | Lisa Williams              |
| <b>Section Manager:</b> | Cherie Rainforth           |
| <b>Branch Chief:</b>    | Dan Donohue                |

# Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

## 1. Early Actions Strategy Name and Proponent

SUMMARY #            *B24*  
ID NUMBER:         *EJAC-25*  
TITLE:                *EVALUATE ENCLOSED DAIRY BARNs AS AN ADDITIONAL STRATEGY FOR THE CAPTURE AND COMBUSTION OF METHANE EMISSIONS AT DAIRIES*  
PROPONENT:        *ENVIRONMENTAL JUSTICE ADVISORY COMMITTEE*

## 2. Staff Recommendation

This measure is recommended for evaluation in the Scoping Plan which will be developed as a draft by mid-2008 and must be considered by the Board prior to January 1, 2009. Evaluation as part of the Scoping Plan provides the most effective approach for fully considering the recommendation.

In addition to this measure, ARB staff will be evaluating potential measures for modified feed management, manure removal frequency, covered and treated lagoons, and digesters as potential strategies for reducing methane emissions.

This evaluation will be undertaken as part of ARB's actions for reducing methane emissions at dairies. These actions are not appropriate for consideration as early action measures because the time-frame is not sufficient to conduct the required in-depth cost-effective analyses, develop consistent emissions testing methods, and evaluate emerging technologies or technology-transfers. These activities must be conducted in advance of proposing any measures for reducing GHG emissions from dairy operations. ARB Planning and Technical Support Division (PTSD) staff is currently developing a protocol for calculating changes in GHG gas emissions resulting from the voluntary installation of a manure digester at animal agricultural facilities. The development of this voluntary protocol has been proposed as an early action measure and is discussed in a separate white paper prepared by PTSD.

## 3. Early Action Description

This strategy proposes that the ARB develop a regulation to require that housing and milking barns at dairies be vented to an incinerator or biofilter/bioscrubber as a means of controlling methane emissions from enteric fermentation. This strategy consists of fully enclosing barns and exhausting the air to an incinerator or a biofilter/bioscrubber.

Incinerators can achieve a 90 percent or greater reduction in methane emissions. However, incinerators emit oxides of nitrogen, carbon dioxide, toxic air pollutants and require the use of a fuel to promote the destruction of compounds such as methane.

Biofilter/bioscrubber technology can achieve approximately 80 percent control of emissions of volatile organic compounds (VOCs), ammonia, and hydrogen sulfide. ARB staff was not able to confirm any control efficiencies for methane from biofilters/bioscrubbers. By-products of biofilters/bioscrubbers are water and carbon dioxide.

In their May 7, 2007 letter to the Chairman of the Air Resources Board, the Center on Race, Poverty & the Environment argues 1) that cow housing is where most enteric fermentation takes place, 2) biofilter systems are already in use for swine facilities and have been reported for dairies, and 3) have been proposed by industry in California. ARB staff has not been able to confirm the extent to which these statements are true. In addition, ARB staff is not aware of any information about the cost of these technologies or their ability to reduce GHG emissions at any enclosed animal facility.

#### **4. Potential Emission Reductions**

California's dairy cow population produces about 4.7 MMTCO<sub>2</sub>E of methane from enteric fermentation. Although biofilters/bioscrubbers and incinerators can reduce methane emissions, the overall net GHG emissions (that would occur after discounting the GHG emissions emitted from electricity required to operate the technologies and as a by-product of the technologies themselves) have not been determined.

#### **5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities**

A detailed cost-effectiveness analysis of such systems needs to be performed prior to their application. In addition, the calculation of net reduction in GHGs must include the electricity used to move contaminated air from the barns to the filtration device or incinerator. The agriculture industry, particularly sectors involved in confined animal facilities, would be impacted by this proposal.

#### **6. Technical Feasibility**

These technologies could theoretically be transferred to dairies. However, the extent to which enclosed animal barns outfitted with these technologies could achieve a net reduction in GHG emissions, particularly carbon dioxide, has not been demonstrated.

#### **7. Additional Considerations**

This is an untested technology with likely high-energy requirements for airflow and high-water requirements for evaporative cooling. There may be some benefits in milk production by maintaining the proper temperatures inside the freestall barns. Manure handling in the confined spaces may be more difficult. An increased risk to animals will occur from overheating. Marketing campaigns based on "unconfined cows" might be compromised. Animal health and welfare issues may arise.

**8. Division:** Stationary Source Division  
**Staff Lead:** Dan Weller  
Regulatory Assistance Section  
**Section Manager:** Kitty Howard  
**Branch Chief:** Michael Tollstrup  
**Staff Attorney:** George Poppic

**9. References:**

1. *Dairy Permitting Advisory Group, Recommendations to the San Joaquin Valley Air Pollution Control Officer Regarding Best Available Control Technology for Dairies in the San Joaquin Valley, Final Report – January 31, 2006, at 108-110 (“DPAG Report”)*
2. *Letter to Dr. Robert Sawyer, Chairman of the California Air Resources Board. Dated: May 7, 2007. Received from Avinash Kar (Center on Race, Poverty, & the Environment) and Tom Frantz (Global Warming Environmental Justice Advisory Committee)*

# Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

## 1. Strategy Name and Proponent

SUMMARY #            *B25*  
ID NUMBER:         *EJAC-26*  
TITLE:                *COMPOSTING – ADOPT SOUTH COAST AND SAN JOAQUIN  
RULES STATEWIDE*  
PROPONENT:        *ENVIRONMENTAL JUSTICE ADVISORY COMMITTEE*

## 2. Staff Recommendation

This measure is recommended for evaluation in the Scoping Plan which will be developed as a draft by mid-2008 and must be considered by the Board prior to January 1, 2009. Evaluation as part of the Scoping Plan provides the most effective approach for fully considering the recommendation.

## 3. Description

South Coast Air Quality Management District (SCAQMD) Rule 1133.2 and San Joaquin Valley Unified Air Pollution Control District (SJV) Rule 4565 were adopted for the purpose of controlling volatile organic compounds (VOC) and ammonia from co-composting facilities. This strategy would adopt SCAQMD and SJV rules for enclosed co-composting facilities statewide. Co-composting is the composting of a mixture of biosolids and manure with bulking agents to produce compost. Greenwaste facilities use green waste or food waste as the primary feedstock, and may add small amounts of manure or other biosolids as an amendment; chipping and grinding facilities reduce the size of greenwaste or wood waste to be used in composting, or as cover for landfills.

## 4. Potential Emission Reductions

This action is expected to have a low (0-0.1 million metric ton carbon equivalent) emissions reduction potential. The composting rules in SCAQMD and SJV were designed to reduce emissions of VOC and ammonia (as precursors to ozone and PM10). GHG emissions were not evaluated during the development of the district rules.

According to U.S. EPA, composting may result in emissions of methane from anaerobic decomposition, and non-biogenic emissions of carbon dioxide (CO<sub>2</sub>) from the collection and transport of the organic materials to the composting site. U.S. EPA considers CO<sub>2</sub> emissions from aerobic decomposition to be “biogenic” and therefore does not include them in the *Inventory of U.S. Greenhouse Gas Emissions and Sinks*. Research indicates that efficient composting will not result in significant methane emissions, will have minimal CO<sub>2</sub> emissions from transportation and mechanical turning of compost piles, and can result in some carbon storage (sequestration) from the application of compost to soils. Methane emissions were estimated to be essentially zero and CO<sub>2</sub> emissions per ton of material composted was estimated to be 0.01 million ton carbon equivalent (MTCE) indirect CO<sub>2</sub>. U.S. EPA estimated that centralized composting of organics

results in net GHG storage of 0.05 MTCE/wet ton of organic inputs composted and applied to agricultural soil.

## **5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities**

SCAQMD evaluated the cost effectiveness of Rule 1133.2 under several scenarios. Under the most likely scenario for an existing facility, with enclosures for all phases of the operation, and biofiltration, the cost was \$8,700 to \$10,000 per ton of VOC and ammonia reduced, depending on the type of enclosure selected. Costs for a new facility were between \$11,000 and \$12,000 per ton. Although greenwaste composting facilities have the largest throughput of any composting operation, they are exempt because the control options were determined to be cost-prohibitive.

## **6. Technical Feasibility**

It would be technically feasible to have all large composting facilities in the State comply with a statewide control measure similar to the SCAQMD or SJV rules. However, it is unclear at this time if the control measure would reduce GHG emissions.

## **7. Additional Considerations**

While implementation of this strategy would certainly result in additional statewide VOC and ammonia benefits statewide, GHG reduction benefits are currently unclear. An analysis is needed to determine whether the controls (enclosure and biofilters) will reduce GHG emissions. Additionally, the Market Advisory Committee report on the establishment of a Cap and Trade Program reported that composting does not produce net greenhouse gas emissions. Furthermore, U.S. EPA has estimated that there is a net GHG storage of 0.05 MTCE/wet ton of organic inputs composted, once they are applied to agricultural soil. Data on GHG emissions from composting operations in the SCAQMD and SJV, as well as other areas of the State, need to be obtained and analyzed in order to determine if this strategy has the potential to result in GHG emission reductions.

With low-to-zero anthropogenic GHG emissions, regulating composting facilities for their GHG emissions alone may be cost prohibitive. The Market Advisory Committee noted that local governments have created incentives for increased composting based on the need to reduce the amount of material sent to landfills. Cities and counties were mandated to achieve a 50 percent source reduction by the year 2000, compared to a 1990 baseline. The current statewide diversion rate is 42 percent. If new regulations are imposed on these facilities, it could hinder further progress towards this goal. Composting, alternatively, may be considered a method of carbon sequestration and therefore a potential offset measure (for example, United States Department of Agriculture research indicates that compost usage can reduce fertilizer requirements by at least 20 percent thereby significantly reducing net GHG emissions), which would enhance the economic viability of composting. These issues need to be carefully considered and analyzed prior to proceeding with this strategy.

**8. Division:** Stationary Source Division  
**Staff Lead:** Kate MacGregor  
**Section Manager:** Richard Boyd  
**Branch Chief:** Dan Donohoue

# Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

## 1. Early Actions Strategy Name and Proponent

SUMMARY #            *B26*  
ID NUMBER:         *EJAC-27*  
TITLE:                *PHASE OUT PRE-1980 POWER PLANTS GENERATING AT  
LEAST 100 MW AND PROVIDE INCENTIVES TO REPLACE  
THEM WITH CLEAN ENERGY*  
PROPONENT:        *ENVIRONMENTAL JUSTICE ADVISORY COMMITTEE*

## 2. Staff Recommendation

This measure is recommended for evaluation in the Scoping Plan which will be developed as a draft by mid-2008 and must be considered by the Board prior to January 1, 2009. Evaluation as part of the Scoping Plan provides the most effective approach for fully considering the recommendation.

ARB staff determined that the greenhouse gas reduction potential of this strategy appears to range from low (actually an increase in emissions) to large, depending on what assumptions are used. ARB staff recommends working with the local air districts to analyze the best options for each generating unit. This work would include determining to what extent natural phase-out is occurring and at what pace; considering how the existing power plants operate versus how the replacement plants will operate (combined-cycle generation is designed for baseload operation and using it as peaking capacity could result in higher emissions due to frequent startup and shutdowns where combustion systems and controls are not optimized); analyzing how planned transmission upgrades will affect the need for Reliability Must Run (RMR) units; and looking at whether new proposed power plant projects will replace the need for old generating units.

## 3. Early Action Description

This strategy proposes that the ARB develop a permitting system to phase out, by 2010, fossil fuel-burning thermoelectric power plants that generate at least 100 MW and were built prior to 1980. The EJAC argues that these represent the oldest, most inefficient units. The mechanism for this phase out would be through a scaled and planned annual reduction in CO<sub>2</sub> emissions between 2007 and 2010. The 2010 end-goal would be an emission standard equivalent to the 2007 cleanest combined-cycle plant operating at a heat rate of 6,500 Btu/kWh. Generating units that cannot meet the emission standard would be required to shut down. The proposed phase-out would occur according to the following increments of progress:

| Year | Allowable CO <sub>2</sub> Emission Level   |
|------|--|
| 2007 | equivalent to 2006 emissions   |
| 2008 | at least 1/2 less than the difference between 2007 emissions and the 2010 standard               |
| 2009 | at least 2/3 less than the difference between 2007 emissions and the 2010 standard               |
| 2010 | equivalent to California's most efficient plants built in 2007 rated at 100 MW and 6,500 Btu/kwh |

EJAC also suggests that ARB prohibit an RMR designation by the California Independent System Operator (CAISO) as a means to allow a unit that does not meet the emission levels to operate.

ARB staff assumes that the power plants in question will be replaced by modern combined-cycle power plants consisting of natural gas-fired combustion turbine generators where heat is recovered from the gas turbine exhaust gases to heat water and generate steam, which is sent through a steam turbine to produce additional electricity. Therefore, the amount of fossil fuel burned to generate electricity is less than older units with no heat recovery. For example, the typical electric generation efficiency of a combined-cycle plant is estimated from 40-58 percent, while a utility boiler is estimated from 25-40 percent.

ARB staff assumes that the power plants in question will be replaced by modern combined-cycle power plants consisting of natural gas-fired combustion turbine generators where heat is recovered from the gas turbine exhaust gases to heat water and generate steam, which is sent through a steam turbine to produce additional electricity. Therefore, the amount of fossil fuel burned to generate electricity is less than older units with no heat recovery. For example, the typical electric generation efficiency of a combined-cycle plant is estimated from 40-58 percent, while a utility boiler is estimated from 25-40 percent.

ARB staff determined there are 59 fossil fuel-fired thermoelectric power plants within California that came online prior to 1980. In 2005, the CO<sub>2</sub> emissions from these facilities totaled 13.9 million metric tons of CO<sub>2</sub>-equivalent per year (MMTCO<sub>2</sub>E) or about 25 percent of total CO<sub>2</sub> emissions from all power plants in California. Of these, 30 power plants are also rated at 100 MW or more. The 30 plants represent three percent of the number of power plants statewide, yet contribute approximately 21 percent of the total MW plant capacity in the State. If all 30 plants are phased out by 2010, the State would need to secure about 20,000 MW of capacity. The facilities are located within the jurisdiction of the following air districts: Bay Area, South Coast, Mojave Desert, San Diego, San Luis Obispo, North Coast, and Ventura. The generating units consist of natural gas-fired utility boilers and combustion turbines, with the exception of one facility that uses jet fuel.

Of these 30 power plants, high heat rates and future longevity may soon be less of an issue due to several factors. First, ARB staff has determined that 18 plants have either replaced all or a portion of their generating units or the old generating units are retired or soon to be retired. Secondly, the State Water Resources Control Board is currently developing a statewide policy to implement federal Clean Water Act requirements for cooling water intake structures related to the mitigation of entrainment and impingement

of marine life at power plants that utilize once-through cooling. ARB staff has identified 17 plants (14,479 MW) that may need to be retrofitted to comply with proposed once-through cooling requirements. These plants may be retired due to the cost to retrofit or may suffer an energy penalty ranging from 1.7 to 8.6 percent (at 67 percent load) to install wet or dry cooling.

Regarding reliance on RMR units, one of the ways to reduce the need to sign RMR contracts is to invest in transmission upgrades. Upgrades that increase the ability to import energy from neighboring states and Mexico, and increase the amount of energy that can be delivered to the major load centers in California, minimize the need to sign RMR contracts with aging facilities in these areas for local reliability purposes. Two major upgrades are scheduled to operating by 2008 and will increase the transmission networks import capability into Southern California by as much as 1,160 MW. The Miguel-Mission 230 kV line #2 will increase the import capability into San Diego by 560 MW and is expected to be operating by June of 2006. The short-term Southwest Transmission Expansion Plan upgrades will increase the import capability into the Los Angeles Basin by approximately 500 MW. There are no other major projects planned to increase the transmission capacity into California before 2009.

As a companion to the phase out of older, higher-emitting plants, this strategy proposes that incentives be provided to encourage clean energy substitutions. Identifying available incentive programs would be included as part of the evaluation for the Scoping Plan. However, there is a potential incentive in Assembly Bill 32 (AB 32) for facilities that implement voluntary reduction measures. AB 32 requires that adopted regulations ensure entities that have voluntarily reduced their greenhouse gas emissions prior to the implementation of these regulations receive appropriate credit for early voluntary reductions (Health and Safety Code Section 38562 (b)(3)). To support these reductions, ARB is required to adopt methodologies for the quantification of voluntary greenhouse gas emission reductions, and adopt regulations to verify and enforce any voluntary reductions that are authorized for use to comply with emission limits established by ARB (Health and Safety Code Section 38571).

#### **4. Potential Emission Reductions**

In 2005, the 59 pre-1980 power plants produced 13.9 million metric tons of CO<sub>2</sub>-equivalent per year (MMTCO<sub>2</sub>E), which is equivalent to 24 percent of the CO<sub>2</sub> produced by power plants. Although available data were incomplete, plant numbers indicate capacity factors<sup>1</sup> ranging from 1.3 to 36.1 percent (average 13.2 percent). While recent data shows these plants operate infrequently, replacing them with new natural gas combined-cycle units would mean that the new plants will operate more because they are designed for baseload generation. Combined-cycle plants tend to have capacity factors around 85 percent<sup>2</sup>. Based on these assumptions, ARB staff estimates the potential emissions impact due to shut down of pre-1980 power plants and replacement with combined-cycle generation in 2010 ranging from a 2.4 MMTCO<sub>2</sub>E reduction (at

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<sup>1</sup> A percentage that tells how much of a power plant's capacity is used over time. It is the ratio of the electrical energy produced by a generating unit for the period of time considered to the electrical energy that could have been produced at continuous full power operation during the same period.

<sup>2</sup> Assumed CO<sub>2</sub> emission factor for combined-cycle generation is 1,100 lb CO<sub>2</sub>/MWh, as proposed in SB 1368 regulations.

13.2 percent capacity factor) to a 60.4 MMTCO<sub>2</sub>E increase (at 85 percent capacity factor). Therefore, the emission reduction potential of this strategy is considered from low to large.

Depending on how well-controlled the existing plants are, there is the potential for criteria pollutant reductions from combined cycle. At the same time, depending on how the new facilities are operated, there is the potential for an overall increase in emissions due to frequent startups and shutdowns or higher capacity factors.

## **5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities**

ARB staff estimates that the cost to implement this strategy is simply the cost of replacing the old power plants with new combined-cycle power plants of identical capacity. As mentioned above, the potential replacement capacity is 20,000 MW. To replace this capacity with equivalent combined cycle generation is estimated to range from \$1.4 to 8.7 billion (using a levelized cost for combined cycle of 5.85 cents/kWh<sup>3</sup>) based on capacity factors from 13.2 to 85 percent. If there is a reduction in emissions, the cost effectiveness is \$564 per-MTCO<sub>2</sub>E. The bulk of the costs will be borne by the electric utility industry. In turn, this could impact consumers in the form of increased electricity rates.

## **6. Technical Feasibility**

The siting of large natural gas-fired combined-cycle plants in California started in 1997, coinciding with the passage of legislation in 1996 deregulating the California electric utility industry. Since then, 19 of these plants, totaling over 10,000 MW, are currently operating throughout the State. Therefore, the technology is proven and well-established.

## **7. Additional Considerations**

Rules of the Oregon Energy Facility Siting Council set CO<sub>2</sub> emission standards for new energy facilities. The standards apply to baseload gas plants, non-baseload power plants, and non-generating energy facilities that emit CO<sub>2</sub>. For baseload gas plants and non-baseload plants, the standard sets the net emissions rate at 0.675 pounds CO<sub>2</sub>/kWh (675 pounds CO<sub>2</sub>/MWh).

On October 30, 2006, the California Energy Commission (CEC) instituted a proceeding to establish a greenhouse gas emission performance standard to implement Senate Bill 1368 (Stats. 2000, Ch. 598). The bill directs the CEC, in consultation with the California Public Utilities Commission and the California Air Resources Board, to establish a greenhouse gas emission performance standard for all baseload<sup>4</sup> generation of local publicly owned electric utilities at a rate no higher than the rate of emissions for natural gas-fired combined-cycle baseload generation. The proposed standard was set at 1,100 pounds of CO<sub>2</sub>/MWh, based on evaluating the performance of existing

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<sup>3</sup> Represents an average of several cost estimates.

<sup>4</sup> ARB staff is awaiting interpretation from the CEC and California Public Utilities Commission regarding whether plants currently operating with low capacity factors (but which were originally designed and intended for baseload operation) are subject to SB 1368 regulations.

combined-cycle natural gas baseload plants throughout the west, with special attention paid to the performance of units in California.

The CEC adopted the regulations pursuant to SB 1368 on May 28, 2007. The final rulemaking package was submitted to the Office of Administrative Law on June 1, 2007. On June 29, 2007, OAL issued a decision disapproving the action. The CEC is currently working on addressing the decision and determining what changes should be made to the proposed regulations to address OAL's concerns.

**8. Division:** Stationary Source Division  
**Staff Lead:** Chris Gallenstein  
**Section Manager:** Mike Waugh  
**Branch Chief:** Mike Tollstrup

## 9. References:

<sup>1</sup> California Air Resources Board, *database on California power plants, based on air district permit information from 2001.*

<sup>2</sup> California Air Resources Board, *spreadsheet on greenhouse gas emissions from power plants for 2005, based on Energy Information Administration data.*

<sup>3</sup> California Energy Commission, "Comparative Cost of California Central Station Electricity Generation Technologies," Staff Report, publication #100-03-001, August 2003.

<sup>4</sup> California Energy Commission, "Initial Statement of Reasons for Adoption of Regulations Establishing and Implementing a Greenhouse Gases Emission Performance Standard for Local Publicly Owned Electric Utilities," Docket #06-OIR-1, February 2007.

<sup>5</sup> California Energy Commission, "Integrated Energy Policy Report," Appendix A: Aging Power Plant Study Group, publication #CEC-100-2005-1007-CMF, November 2005.

<sup>6</sup> California Energy Commission, "Inventory of California Greenhouse Gas Emissions and Sinks 1990 to 2004," Staff Final Report, publication #CEC-600-2006-013-SF, December 2006.

<sup>7</sup> California Energy Commission, *Power Plant Licensing Cases, Status of All Projects*, last updated 7/25/07: [http://www.energy.ca.gov/sitingcases/all\\_projects.html](http://www.energy.ca.gov/sitingcases/all_projects.html)

<sup>8</sup> California Energy Commission, "Proposed 15-Day Changes to Regulations Establishing and Implementing a Greenhouse Gases Emission Performance Standard for Local Publicly Owned Electric Utilities," Docket #06-OIR-1, May 2007.

<sup>9</sup> California Energy Commission, "Resource, Reliability and Environmental Concerns of Aging Power Plant Operations and Retirements," Draft Staff White Paper, publication #100-04-005D, August 13, 2004.

<sup>10</sup> California Energy Commission, "Status and Known Plans of Coastal Plants using OTC," April 2007.

<sup>11</sup> California Energy Commission, *spreadsheet on pre-1980 generating unit ratings and status.*

<sup>12</sup> Council of Industrial Boiler Owners, "Energy Efficiency & Industrial Boiler Efficiency: An Industry Perspective," March 2003.

<sup>13</sup> Energy Information Administration Glossary: <http://www.eia.doe.gov/glossaryindex.html>

<sup>14</sup> Julie Gill, CAISO, personal communication, 7/24/07.

<sup>15</sup> Oregon's Power Plant Offset Program: [http://www.climatetrust.org/programs\\_powerplant.php](http://www.climatetrust.org/programs_powerplant.php)

<sup>16</sup> Siemens Power Generation, Combined Cycle Plant Ratings, January 2006:  
<http://www.powergeneration.siemens.com/en/planrating/index.cfm>

<sup>17</sup> U.S. Department of Energy, Energy Information Administration, Office of Integrated Analysis and Forecasting, "Annual Energy Outlook 2007 with Projections to 2030," February 2007.

<sup>18</sup> U.S. Department of Energy, National Energy Technology Laboratory, "Cost and Performance Baseline for Fossil Energy Plants," Volume I, DOE/NETL-2007/1281, May 2007.

# Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

## 1. Early Actions Strategy Name and Proponent

SUMMARY #            *B27*  
ID NUMBER:         *EJAC-28*  
TITLE:                *PROHIBIT FUEL OIL BURNING IN PRE-1980 POWER PLANTS  
GENERATING AT LEAST 100 MW*  
PROPONENT:        *ENVIRONMENTAL JUSTICE ADVISORY COMMITTEE*

## 2. Staff Recommendation

This measure is recommended for evaluation in the Scoping Plan which will be developed as a draft by mid-2008 and must be considered by the Board prior to January 1, 2009. Evaluation as part of the Scoping Plan provides the most effective approach for fully considering the recommendation.

ARB staff determined that the greenhouse gas reduction potential of this strategy is low. All power plants in California built prior to 1980 and rated at 100 MW or more with oil-firing capability utilize fuel oil only for backup purposes. There is one small plant on Catalina Island rated at 9.3 MW that uses diesel as the primary fuel.

## 3. Early Action Description

This strategy proposes that the ARB develop a regulation to prohibit the burning of fuel oil at power plants that generate at least 100 MW and were built prior to 1980. ARB staff determined there are no power plants of 100 MW or more in California that were constructed before 1980 and that burn fuel oil as the primary fuel. There are, however, 11 plants greater than 100 MW that are permitted to burn fuel oil as backup. They are located within the jurisdiction of the following air districts: Imperial, San Diego, South Coast, North Coast, and Bay Area. During 2005, four of these 11 plants used fuel oil for some portion of the year. The combined diesel and residual fuel oil consumption during 2005 emitted an estimated 0.068 million metric tons of CO<sub>2</sub>-equivalent (MMT<sub>CO2E</sub>), or only 0.12 percent of the total CO<sub>2</sub> emissions from all California power plants.

In addition, there are five power plants rated less than 100 MW that utilize fuel oil as the primary fuel. They are located in South Coast, Placer County, and Northern Sierra air districts. Generating units at four of the five plants have been retired; only the Pebbly Beach Generating Station on Catalina Island remains operational.

The longevity of four of the 11 power plants may be affected by proposed State Water Resources Board policy pertaining to coastal power plants that have once-through cooling. Once-through cooling draws sea water into the plant, where it flows through a heat exchanger to cool the steam, and then subsequently returns the heated water back to the source. Sea water is abundant and cold and represents an efficient means of handling plant waste heat. However, once-through cooling may have a deleterious

environmental impact due to the entrainment and impingement of marine life; therefore, the State Water Resources Control Board is currently developing a statewide policy to implement federal Clean Water Act requirements for power plants that utilize once-through cooling. The policy may require retrofit with an alternative cooling system such as wet or dry cooling. These plants may be retired due to the cost to retrofit.

#### **4. Potential Emission Reductions**

To determine potential emission reductions, ARB staff looked at the difference in emissions due to use of alternative fossil fuels with a lower carbon profile using 2005 as the baseline and assuming 2010 consumption data will be similar. As stated above, diesel and fuel oil burning in 2005 produced 0.068 MMTCO<sub>2</sub>E. Replacing fuel oil with liquefied petroleum gas (LPG) would result in a 14 percent reduction (0.010 MMTCO<sub>2</sub>e) in 2010. To replace with natural gas would result in a 25 percent reduction (0.017 MMTCO<sub>2</sub>e). Therefore, the emission reduction potential of this strategy is considered to be low.

#### **5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities**

The primary cost associated with this strategy is expected to consist of either the cost of lost power when it is needed (i.e., during a gas curtailment) or the price and cost of an alternative fuel, such as LPG, and its associated infrastructure. It is also possible that some of the generating units (e.g., burners) may need to be retrofitted to accommodate a different fuel.

The costs to businesses and consumers for lost power requires more in-depth research and was not determined for purposes of this analysis; however, it is expected to be significant, particularly depending on the frequency, timing, and duration of these events.

With respect to the use of alternative fuels, the cost of an equivalent amount of LPG is less than the combined diesel and fuel oil consumption for 2005. However, without specific plant information, ARB staff cannot determine any additional costs associated with infrastructure and equipment retrofits at this time.

#### **6. Technical Feasibility**

Power generating boilers, combustion turbines, and reciprocating engines that operate on a variety of fossil fuels are not new technologies. Some of the generating units in question may already have dual-fuel firing capability and thus the conversion from oil burning to a lower carbon fuel is not expected to require any equipment retrofits. Other units will have to be looked at on a case-by-case basis to determine the feasibility of retrofits such as replacement of burner orifices to accommodate various fuels.

Another factor to consider with respect to feasibility is that facilities may be limited by geography in terms of fuel supply choices. For example, the Pebbly Beach Generating Station is located on Catalina Island just off the coast from Los Angeles and utilizes diesel fuel in their reciprocating engine generators. In addition, some regions have the need for dual-fuel capability due to natural gas curtailments. Adverse weather conditions, particularly in Northern California, during which commercial and industrial

space heating loads are high, can result in natural gas curtailments and spur the need for dual-fuel capability to meet power requirements.

## 7. Additional Considerations

Some California local air districts have prohibitory rules that apply to power generating units that directly prohibit oil burning after a certain date. Other district rules may indirectly result in the phase out of oil burning through average emission standards that apply to multiple generating units. In order to maximize operation, these power plants would be motivated to switch to cleaner-burning fuels, install emission control technologies, or a combination of both.

**8. Division:** Stationary Source Division  
**Staff Lead:** Chris Gallenstein  
**Section Manager:** Mike Waugh  
**Branch Chief:** Mike Tollstrup

## 9. References:

*California Air Resources Board, database on California power plants, based on air district permit information from 2001.*

<sup>2</sup> *California Air Resources Board, District Rules Database, main page last updated 3/24/05: <http://www.arb.ca.gov/drdb/drdb.htm>*

<sup>3</sup> *California Air Resources Board, spreadsheet on greenhouse gas emissions from power plants for 2005, based on Energy Information Administration data.*

<sup>4</sup> *California Energy Commission, "Integrated Energy Policy Report," Appendix A: Aging Power Plant Study Group, publication #CEC-100-2005-1007-CMF, November 2005.*

<sup>5</sup> *California Energy Commission, "Inventory of California Greenhouse Gas Emissions and Sinks 1990 to 2004," Staff Final Report, publication #CEC-600-2006-013-SF, December 2006.*

<sup>6</sup> *California Energy Commission, "Resource, Reliability and Environmental Concerns of Aging Power Plant Operations and Retirements," Draft Staff White Paper, publication #100-04-005D, August 13, 2004.*

<sup>7</sup> *California Energy Commission, "Status and Known Plans of Coastal Plants using OTC," April 2007.*

<sup>8</sup> *California Energy Commission, spreadsheet on pre-1980 generating unit ratings and status.*

<sup>9</sup> *Energy Information Administration, Spot Prices for Crude Oil and Petroleum Products, last updated 7/25/07: [http://tonto.eia.doe.gov/dnav/pet/pet\\_pri\\_spt\\_sl\\_d.htm](http://tonto.eia.doe.gov/dnav/pet/pet_pri_spt_sl_d.htm)*

<sup>10</sup> *Energy Information Administration, Spot Prices for Crude Oil and Petroleum Products, last updated 7/25/07: [http://tonto.eia.doe.gov/dnav/pet/pet\\_pri\\_gnd\\_dcus\\_nus\\_w.htm](http://tonto.eia.doe.gov/dnav/pet/pet_pri_gnd_dcus_nus_w.htm)*

<sup>11</sup> *Energy Information Administration, Weekly Heating Oil and Propane Prices, last updated 4/19/07: [http://tonto.eia.doe.gov/dnav/pet/pet\\_pri\\_wfr\\_dcus\\_nus\\_w.htm](http://tonto.eia.doe.gov/dnav/pet/pet_pri_wfr_dcus_nus_w.htm)*

# Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

## 1. Early Actions Strategy Name and Proponent

SUMMARY #            B28  
ID NUMBER:         *EJAC-30/ARB 1*  
TITLE:                *REFINERY METHANE EMISSIONS*  
PROPONENT:         *2006 CAT REPORT and STAKEHOLDER SUGGESTION*

## 2. Staff Recommendation

This measure is recommended for evaluation in the Scoping Plan which will be developed as a draft by mid-2008 and must be considered by the Board prior to January 1, 2009. Evaluation as part of the Scoping Plan provides the most effective approach for fully considering the recommendation.

Currently, there is no reporting system that identifies the sources and quantity of methane emissions from refineries. However, the draft 2004 California GHG inventory lists California petroleum refinery emissions as 30 million metric tons of CO<sub>2</sub> equivalents. Using Air Resources Board (ARB) Emission Inventory Data<sup>1</sup> and ARB refinery speciation profiles it is estimated that refinery methane emissions are 1.4 million metric tons of CO<sub>2</sub> equivalents. Recent refinery studies<sup>2</sup> suggest that the majority of the methane emissions come from crude oil transfer operations, fugitive losses (valves and fittings), flares, cooling towers, and wastewater treatment.

Staff proposes to:

- (a) Perform an evaluation to determine sources and magnitude of refinery methane emissions; and
- (b) Develop a detailed strategy to define regulatory measures for monitoring and control of methane exemptions granted to refineries. This will include methane control measures for refinery processes currently controlled under non-methane volatile organic compounds emission limits, and for some sources with limited control requirements, e.g., cooling towers, wastewater treatment, and ponds.

## 3. Early Action Description

Methane is emitted from many refining operations. The major sources of methane emissions are vapor displacement from crude tanks from marine off-loading and refinery desalter emissions. During the refining processes, methane is separated from the crude oil through vacuum or atmospheric distillation. Methane emissions occur when gaseous streams are transported at various points in the refinery. The primary method for

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<sup>1</sup> ARB Almanac database

<sup>2</sup> *Phone communication with Don Robinson, ICF Consulting, 7/20/2007. ICF Consulting is performing a methane study for the American Petroleum Institute. The study will determine the GHG emissions for refineries. This analysis will determine CO<sub>2</sub>, methane, and N<sub>2</sub>O for all U.S. refineries. Email Communication: Don Robinson [DRobinson@icfi.com](mailto:DRobinson@icfi.com)*

controlling methane emissions is the use of combustion devices, i.e., flare. If one excludes marine off-loading and refinery desalter emissions, most if not all refinery methane sources are low energy, i.e., low heating value, vapor streams<sup>3</sup> that cannot be economically recovered.

#### **4. Potential Emission Reductions**

The potential emission reductions from this measure are unknown.

#### **5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities**

There is no accurate estimate of the costs or the economic impacts. It is expected that the costs, depending on the source, could range from low to high. For new or exempt sources the costs may be high. In contrast, existing non-methane hydrocarbon control systems already control methane emissions by default. The major impact on existing control systems would be to require that methane be included in emission capture or destruction efficiencies.

#### **6. Technical Feasibility**

Monitoring and implementation of methane emission control measures is technically feasible. However, many California refineries do not use Best Available Control Technology (BACT) for known methane sources. Use of methane BACT may require additional work for design, local planning approval, and installation. Technology that meets refinery methane BACT has been installed in some California refineries. Use of a catalytic combustion device at the Shell Martinez marine loading terminal is a good example of a methane BACT installation. Mandatory use of BACT for all crude transfer operations and refinery desalter emissions will control most methane emissions by default.

#### **7. Additional Considerations**

None

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|-------------------------|----------------------------|
| <b>8. Division:</b>     | Stationary Source Division |
| <b>Staff Lead:</b>      | Tim Dunn                   |
| <b>Section Manager:</b> | John Courtis               |
| <b>Branch Chief:</b>    | Dean Simeroth              |

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<sup>3</sup> Ernest Orlando Lawrence Berkeley National Laboratory, Environmental Energy Technologies Division, *Profile of the Petroleum Refining Industry of California* (March 2004). The report was supported by the California Energy Commission through the U.S. Department of Energy under Contract No. DE-AC03-76SF00098.



systems in 2011 and 2 percent for new systems by 2016<sup>3</sup>. Currently it is estimated that the average leak rate for new systems is approximately 15 percent minimum. The 5 percent maximum annual leak rate by 2011 is based on industry estimates for controlling leaks in centralized direct expansion (DX) systems, which are the predominant systems currently being installed in retail food stores<sup>4</sup>. To reach the proposed 2020 limit of 2 percent for the maximum annual leak rate, it is expected that indirect supermarket refrigeration systems will have to be adopted rather than low-leak or low-charge DX designs or distributed systems.

Additionally, based on commercially available technologies, the following energy efficiency improvements to reduce energy consumption in existing and new retail food stores are proposed: 10 percent reduction in energy usage from the current baseline in 2011 and 30 percent in 2016<sup>5</sup>. These measures will be pursued in coordination with the California Energy Commission (CEC).

The technologies required for leak reduction in retail food systems include the following: sensitive leak detection equipment, fixed leak detection methods, utilizing brazed (welded) joints instead of flanged or threaded (mechanical) joints, compressor vibration reduction, and improved or reduced numbers of Schrader valves. Additionally, owners and operators of retail food systems would be required to adopt general policies to have full accessibility to all refrigerant pipe work.

Technologies involved in advanced-design retail food refrigeration systems include reduced charge DX systems, distributed systems, secondary loop (indirect) systems, and CO<sub>2</sub> systems (indirect, cascade, and trans-critical systems). Advanced retail food refrigeration designs serve to reduce refrigerant charge (which is important in case of ruptures) as well as reducing leaks through shorter lines that employ fewer fittings.

The improvement of energy efficiency of retail food systems includes the following technologies: evaporative condensers, high efficiency compressor designs, floating head pressure controls, heat recovery, ambient or mechanical sub-cooling, variable speed fans/motors, improved heat exchangers, hot gas defrost, adding doors or night curtains to display cases, energy-efficient reach-ins, anti-sweat heater controls, indirect or energy-efficient case lighting.

#### **4. Potential Emission Reductions**

Estimated emission reductions of **4.7 MMTCO<sub>2</sub>E** in 2020 are possible based on a growth rate of 2 percent for new retail food systems in California (from the updated CAT Work Plan); this number only includes reduced leak rate designs for new systems and energy efficiency improvements for new and existing supermarket systems. If closed cases or night curtains are required, further CO<sub>2</sub> reductions are possible.

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<sup>3</sup> This strategy, which could be applied to all RAC systems over a given capacity, basically applies to retail food systems since other "large" systems currently have much lower leak rates than retail food systems, which have baseline leak rates of 15%.

<sup>4</sup> Industry estimates of improvements and target dates were obtained from European studies, and were presented by The Alliance for Responsible Atmospheric Policy (ARAP) in a meeting with ARB on 10/10/06.

<sup>5</sup> Adding doors or night covers to display cases is not included in the energy reduction estimate, and is expected to result in even greater energy benefits if utilized.

The US EPA has indicated that statewide reductions of approximately 6.8 MMTCO<sub>2</sub>E in 2020 are possible for various RAC strategies ranging from leak reduction and refrigerant recovery to indirect retail food ammonia systems<sup>6</sup>. Their estimate includes measures, such as mandatory leak repair for existing systems, which ARB is considering separately. Furthermore, the estimate of 4.7 MMTCO<sub>2</sub>E is a lower bound, as other measures such as mandatory reporting/repair/refrigerant deposit and return, are expected to increase the turnover rate of old systems and lead to further GHG reductions.

## **5. Estimated Costs/Economic Impacts and the Impacted Sectors/Entities**

The estimated cost of the strategies discussed in this evaluation are expected to be on the order of \$10-\$20/MTCO<sub>2</sub>E in 2020. Estimates by the US EPA range from a savings of \$3/TCO<sub>2</sub>E (for enhanced leak repair and refrigerant recovery) to costs of \$10/MTCO<sub>2</sub>E (for installation of an ammonia-based indirect supermarket system). Costs in the updated CAT report were estimated to be \$14/MTCO<sub>2</sub>E, based on incremental cost differences of 20% between indirect systems and traditional DX systems.

Cost-effectiveness will improve as contractors gain comfort with installation of indirect systems and energy saving devices, and as prices for such devices/system components drop with increased production.

## **6. Technical Feasibility**

Leak reduction technologies were obtained from industry estimates of possible leak tightness improvements. Performance of advanced systems designs has been documented in US EPA, California Energy Commission (CEC), and Oak Ridge National Lab (ORNL) reports.

Information on energy saving technologies were obtained from US Department of Energy (DOE), American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), and US EPA reports, and from presentations given by Charles Zimmerman (Wal-Mart), and Denis Clodic (ARMINES) at ARB's International Symposium On Near-Term Solutions for Climate Change Mitigation in California on March 6, 2007.

All leak reduction and energy efficiency improvement technologies appear to be proven commercially-available technologies; ARAP presented leak reduction technology to ARB based on European experiences with retail food systems, and Wal-Mart has employed advanced design refrigeration systems (secondary loop with heat reclaim) as well as other energy saving measures (LED lighting, closed cases, motion detection for lighting, machine room improvements) with aggressive energy efficiency goals of 25-30 percent reductions in 4 years.

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<sup>6</sup> Obtained from subtracting out motor vehicle A/C reductions and distributing the national reductions to California using the 2005 population fraction of approximately 12.2%.

## 7. Additional Considerations

Given the necessary inventory research, technical complexity and stakeholder input process, staff believes this item could be developed into a regulatory proposal to be considered by the Board by the fourth quarter of 2010.

The affected entities will be owners and operators of retail food (or similar built-up) refrigeration systems, as well as contractors/technicians who install/repair such systems and manufacturers of system components.

A partial list of trade associations possibly impacted, either positively or negatively, by the regulation follows: ARAP (described previously), the Air-Conditioning and Refrigeration Institute (ARI), ASHRAE, North American Technician Excellence (NATE), California Grocers Associations.

Coordination with the US EPA and CEC with respect to developing the regulation is ongoing.

**8. Division:** Research Division  
**Staff Lead:** Whitney Leeman  
**Section Manager:** Michael Robert  
**Branch Chief:** Richard Corey

## 9. References

*Alliance for Responsible Atmospheric Policy (ARAP)/CARB workshop, 10/06.*

*Arthur D. Little, Inc., Global Comparative Analysis of HFC and Alternative Technologies for Refrigeration, Air Conditioning, Foam, Solvent, Aerosol Propellant, and Fire Protection Applications, Final Report to the Alliance for Responsible Atmospheric Policy, March 21, 2002.*

*Arthur D. Little, Inc., Energy Savings Potential for Commercial Refrigeration Equipment Final Report, prepared for Building Equipment Division Office of Building Technologies U.S. Department of Energy, June, 1996.*

*ASHRAE Transactions: 2002 Transactions, Vol. 108, Pt. 1, AC-02-7-2 - Performance and Energy Impact of Installing Glass Doors on an Open Vertical Deli/Dairy Display Case.*

*ASHRAE Transactions: 2005 Transactions, The 2005 Winter Meeting, Orlando, Vol. 111, Pt. 1, OR-05-16-1 - Humidity Effects on Supermarket Refrigerated Case Energy Performance: A Database Review.*

*California EPA, Climate Action Team Report to Governor Schwarzenegger and the Legislature, 4/3/06.*

*David Godwin (USEPA), Marian Martin Van Pelt and Katrin Peterson (ICF Consulting), Modeling Emissions of High Global Warming Potential Gases from Ozone Depleting Substance Substitutes, 2003.*

*ICF Consulting, Emission Reduction Opportunities for Non-CO<sub>2</sub> Greenhouse Gases in California, Consultant Report prepared for CEC PIER Program, CEC-500-2005-121, July 2005.*

*IPCC/TEAP, IPCC Special Report on Safeguarding the Ozone Layer and the Global Climate System, Issues related to Hydrofluorocarbons and Perfluorocarbons, 2005.*

*Solvay Fluor, Advances in Supermarket Refrigeration Leak Reduction, Product Bulletin No. C/07.05/23/E*

*Southern California Edison, Foster-Miller, Inc. Investigation of Secondary Loop Supermarket Refrigeration Systems, Consultant Report prepared for CEC PIER Program, 500-04-013, March 2004.*

*USEPA, U.S. High GWP Emissions 1990-2010: Inventories, Projections and Opportunities for Reductions, EPA 000-F-97-000, June 2001.*

*US Census Bureau, 2002 Economic Census Manufacturing Industry Series, Air-Conditioning and Warm Air Heating Equipment and Commercial and Industrial Refrigeration Equipment Manufacturing: 2002, EC02-311-333415 (RV), December 2004.*

*Van D. Baxter, Advances In Supermarket Refrigeration Systems, Oak Ridge National Laboratory, Oak Ridge, TN 37831-6070*

*Van D. Baxter, Oak Ridge National Laboratory, IEA Annex 26: Advanced Supermarket Refrigeration/Heat Recovery Systems, Final Report Volume 1 – Executive Summary, April 2003.*

# Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

## 1. Early Actions Strategy Name and Proponent

SUMMARY #            *B30*  
ID NUMBER:         *SCAQMD-1*  
TITLE:                *ACCELERATE INTRODUCTION AND DEPLOYMENT OF LIGHT-DUTY VEHICLE (PASSENGER) HYBRID TECHNOLOGY*  
PROPONENT:         *SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT*

## 2. Staff Recommendation

Hybrid technology is an element anticipated to be embedded in additional regulatory measures aimed at further reducing greenhouse gas emissions from new motor vehicles. Thus, this measure is recommended to be considered as part of the analysis for the strategy to strengthen light-duty vehicle standards (B33).

During ARB development of the GHG regulation in response to AB 1493, staff carefully considered the strong benefits of hybrids in reducing CO<sub>2</sub> emissions. One of the hurdles identified to accelerating the introduction of light-duty vehicle hybrid-technology is that hybrid electric powertrains, which include an electric motor, battery pack, power controller and other components are relatively expensive. Accordingly, staff needed to consider the degree of hybridization appropriate and cost effective for the 2009-2016 timeframe. Staff concluded implementation of full hybrid electric vehicles would be premature prior to 2016 but believed that much could be done to prepare the vehicle fleet for incorporation of full hybrids in the meantime.

Accordingly, staff included integrated starter/generator (ISG) components in nearly half of the vehicle technology package combinations that were modeled and subsequently utilized to set the adopted GHG emission standards. This provides the incentive and foundation for vehicle manufacturers to include ISG components into high volume applications, thereby driving down costs of these hybrid systems. Staff concluded that once ISG components were integrated across most of the vehicle fleet, it would be further cost-effective to increase the capability and size of these components to permit cost-effective full hybrids to be developed for deployment in the post 2016 timeframe, i.e., ones that could operate on all electric power and provide plug-in capability, assuming battery development in the meantime progresses favorably to reduce their size and cost and to improve performance and durability.

Staff also identified another hurdle - lead time for incorporating major powertrain changes throughout vehicle manufacturers' product lines. Generally powertrain changes require fairly long lead times due to the need to first develop the new components, integrate them seamlessly into the powertrain, and then test and refine them for optimum performance, reliability and durability. In addition, new machinery for producing such powertrains requires considerable planning, lead time and investment. As a result, staff provided long lead times to enable major powertrain upgrades such as incorporating

hybrid systems into vehicles when manufacturers would be doing major revisions anyway as part of their normal vehicle powertrain life cycle process. This was done to avoid the excessive costs that accompany premature tear up of existing powertrains before their cycle life has expired.

### **3. Early Action Description**

Modify the existing light-duty motor vehicle GHG emissions standards to require greater reductions, thereby forcing vehicle manufacturers to accelerate the introduction and deployment of hybrid technology.

### **4. Potential Emission Reductions**

The currently adopted standards call for about a 30 percent reduction by 2016. Assuming that the new standards would call for about a 50 percent reduction, phased-in beginning in 2017, this measure would achieve about a 4 MMT reduction in 2020. The reduction achieved by this measure would significantly increase in subsequent years as clean new vehicles replace older vehicles in the fleet – staff estimates a 2030 reduction of about 27 MMT.

### **5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities**

Since the technology is at an early stage of development, it is premature to estimate costs and economic impacts.

### **6. Technical Feasibility**

While this measure is technically feasible, for the reasons stated above staff does not believe it would be cost-effective prior to 2017.

### **7. Additional Considerations**

Hybrid technology needs further development and cost reduction if it is to be accepted by large numbers of consumers.

**8. Division:** Mobile Source Control Division  
**Staff Lead:** TBD  
**Section Manager:** Tony Andreoni  
**Branch Chief:** Analisa Bevan

### **9. References:**

*Initial Statement of Reasons for Proposed Rulemaking, Public Hearing to Consider Adoption of Regulations to Control Greenhouse Gas Emissions from Motor Vehicles.*

# Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

## 1. Early Actions Strategy Name and Proponent

SUMMARY #            *B31*  
ID NUMBER:         *SCAQMD-2*  
TITLE:                *NATURAL GAS REQUIREMENT OF 1360 WOBBE INDEX*  
PROPONENT:        *SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT*

## 2. Staff Recommendation

Staff is aware that there are several outstanding issues related to establishing a statewide Wobbe Index standard and the relationship of Wobbe Index and GHG emissions. Thus, staff recommends that ARB continue to coordinate with the SCAQMD to further evaluate the appropriateness of a statewide natural gas Wobbe Index specification.

## 3. Early Action Description

Establishing a statewide natural gas specification of 1360 Wobbe Index would ensure that California's historical average Wobbe Index level would be maintained. California imports about 85 percent of its natural gas supplies via the interstate pipeline; this gas historically meets a 1360 Wobbe Index. However, sources of high Wobbe Index gas, which includes California gas production and potential imported gas derived from liquefied natural gas (LNG), could significantly increase the Wobbe Index of natural gas in Southern California.

Preliminary information indicates that, in general, natural gas inherently meeting a Wobbe Index of 1360 at production has a lower GHG emissions potential than natural gas inherently meeting a Wobbe Index greater than 1360. This is also true for natural gas that has been processed for natural gas liquids (NGLs) extraction to reduce the level of a high Wobbe Index gas to a lower level. In these cases, the methane content (higher hydrogen to carbon ratio) is greater in natural gas meeting a lower Wobbe Index than natural gas meeting a higher Wobbe Index. However, reducing the Wobbe Index of natural gas by inert injection (e.g. nitrogen), would likely result in no or minimal GHG benefits since the dilution effect does not change the GHG potential on an energy (BTU) basis.

Recent action by the California State Lands Commission on the North Baja Pipeline Expansion project recognized the significance of introducing high Wobbe Index gas into California. Although the Commission approved the project, the Commission conditioned the approval by requiring the project proponent to monitor the Wobbe Index level of the gas being brought into California from the project and to mitigate possible NOx increases that could result from the use of that gas.

By establishing a natural gas specification of 1360 Wobbe Index, all gas would have to meet this standard, therefore maintaining the historical average Wobbe Index level. However, depending on the strategies used to meet this specification, GHG emission reductions may or may not be significant.

This strategy would be regulatory and affect the natural gas production and supply sectors.

#### **4. Potential Emission Reductions**

The GHG emissions benefit of this strategy is associated with the potential to avoid GHG emissions that may result from increasing the natural gas Wobbe Index above historical average levels. As discussed, the GHG emissions benefit associated with this strategy is highly dependent on the strategies used to meet a 1360 Wobbe Index specification. If natural gas liquids extraction is applied to natural gas to reduce the level of Wobbe Index to meet proposed specification, then there is a likely GHG benefit of about 1.5 percent going from a Wobbe Index of 1385 to 1360. If inerts injection were used, there would be zero to minimal GHG emissions benefit.

#### **5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities**

The cost of this strategy has not been specifically evaluated. However, rough estimates may be applicable from prior evaluations of natural gas treatment options which include NGLs extraction and inerts (e.g. nitrogen) injection. NGLs extraction can range as low as \$0.04 per million BTU of gas processed and ranges from \$0.24 to \$0.42 per million BTU of gas processed when considering added storage and distribution infrastructure. Also, when considering inerts injection, this option ranges from \$0.05 to \$0.10 per million BTU of gas processed.

The natural gas industry and rate payers would be affected.

#### **6. Technical Feasibility**

Establishing a natural gas specification of 1360 Wobbe Index is technically feasible. Technology to treat natural gas to reduce the Wobbe Index is well proven but the degree of treatment is economically driven depending on the source of natural gas production and the market where the natural gas is to be sold.

#### **7. Additional Considerations**

The California Public Utilities Commission (CPUC) previously held rulemaking to establish a natural gas pipeline specification for Wobbe Index. After considering comments including a recommendation to establish a Wobbe Index of 1360, the CPUC approved a natural gas specification of 1385 Wobbe to ensure adequate supplies of natural gas. The CPUC at that time did not consider the impact of GHG emissions in their decision.

As mentioned, the jurisdiction of establishing a statewide natural gas pipeline specification for Wobbe Index needs to be clarified. Obviously, the CPUC has historical authority to regulate natural gas quality. However, under AB32, the authority to regulate

natural from a GHG perspective suggests that other agencies such as ARB now have some aspects of regulatory authority.

Currently, proposed SCAQMD -2 is not a Climate Action Team strategy.

Proposed SCAQMD-2 would be a regulatory item. Given the regulatory and technical issues that need to be addressed, development of this strategy would exceed 18 months. Further complications in developing this strategy are tied to efforts to address natural gas interchangeability. There are ongoing interchangeability test programs being sponsored by the California Energy Commission that are evaluating the effects of natural gas variability on the performance, durability, and emissions of stationary and mobile combustion equipment. Limited data indicates that certain combustion equipment can be adversely impacted as the Wobbe Index of natural gas increases resulting in increased criteria pollutants. These test programs will provide the technical basis for establishing a statewide natural gas interchangeability specification. These programs are scheduled to be completed within the next 12 to 18 months.

**8. Division:** Stationary Source Division  
**Staff Lead:** Jim Guthrie  
**Section Manager:** Gary Yee  
**Branch Chief:** Dean Simeroth

#### **9. References:**

- *CPUC Order to Institute Rulemaking R.04-01-025*
- *CEC Public Interest Energy Research (PIER) program on natural gas interchangeability*
- *Decision of the California State Lands Commission on the North Baja Pipeline Expansion Project, July 13, 2007.*

# Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

## 1. Early Actions Strategy Name and Proponent

SUMMARY #            *B32*  
ID NUMBER:         *SCAQMD-3/ARB 2-9*  
TITLE:                *LIGHT COLORED PAVING, COOL ROOFS, AND SHADE TREES*  
PROONENT:         *SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT*

## 2. Staff Recommendation

This measure was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, it is recommended that this measure remain as an early action item. The Board date for consideration of this item is anticipated in 3<sup>rd</sup> quarter of 2008.

A non-regulatory strategy (guidance) for further action by businesses, developers, and/or individuals to reduce GHG emissions remains an early action as approved by the Board at its June 2007 hearing. In coordination with the California Energy Commission and the Lawrence Berkeley National Lab (LBNL), staff will develop research and real-world experience-based guidelines on actions that could be taken, documenting options, costs, and benefits. We would draw from local, national, and international experience. The guidelines would be neither a complete nor a necessarily suitable recommendation for every community, but rather a foundation or menu of options applicable to a broad range of communities. The development of the guidance may reveal the need for supplemental tools (e.g., calculators, sector targeted guidelines). Guidelines will be developed in close collaboration with business, community, and environmental stakeholders to ensure that the approach is as effective as possible.

## 3. Early Action Description

We recommend a non-regulatory voluntary program with a set of guidelines to be adopted to foster the establishment or transition to cool communities in California. The affected economic sector is the construction industry. Many of the technologies are already well established. Below is a brief description of the strategies expected to be addressed in the guidelines.

### Cool Roofs

Cool roof programs as part of the Building Energy Efficiency standards (Title 24) which can save as much as 15 percent of cooling energy use during hot months of the year. Such a program has already been proposed (Hebert, 2005). Confined to a residential cool community program, the per-house cost premium is estimated at about \$500 (Professor Akbari).

### Cool Pavements

Pomerantz (1999) suggests that for the urban area of Los Angeles (10,000 km<sup>2</sup> and 1,250 km<sup>2</sup> paved), a change to cool pavements can result in reduction of ambient

temperature by 0.6°C (1°F). This reduction is estimated to result in ozone avoidance benefits of \$75 million (\$228 million extrapolated to California) and energy conservation benefits of \$15 million per year. In 1990, California had 410,000 km<sup>2</sup> in total area with 28 urbanized areas with a total of 15,624 km<sup>2</sup> (5,091 km<sup>2</sup> in Los Angeles). By 1999, the urban area of the state may have reached 30,689 km<sup>2</sup> and the total paved area may have been 3,836 km<sup>2</sup> (3800 km<sup>2</sup> available for cool pavement retrofit).

It is estimated that a cool pavements program would require a premium price of \$0.5 per square yard as there are additional costs associated with painting the surfaces. Manville and Shoup (2005) identified the fraction of paved area devoted to parking as 24% for the Los Angeles business district, leaving 76% of paved area for the cool pavement program; this is to keep separate the cool pavement and the parking shade program.

#### Shade Trees and Urban Forest

The Tree Benefit Estimator reports that a mature tree system would save about 700 kWh of energy (1,100 kg of CO<sub>2</sub> per household)

(<http://www.appanet.org/treeben/calculate.asp>). Mature trees can cost as much as \$300 per tree or \$1200 for 4 trees surrounding a residence.

Taha et al. (2000) reported (“Three Cities,”) an ambient temperature reduction of 1.2K to 1.6K for a heavily vegetated scenario; Scott et al. (1999) reported increased parking lot shade reductions of 5°C to 7°C (2,592 m<sup>2</sup> shaded area covered by 23 mature trees) while the City of Sacramento guidelines recommend 22 trees providing 776 m<sup>2</sup> of shade. Manville and Shoup (2005) identified 24 percent of the paved area of Los Angeles central business district (LACBD) devoted to parking. Following that same logic and using Scott et al. nearly 8 million mature trees would be needed to offer complete shade to every parking lot in California. For Sacramento, 486 mW peak power (and 92,000 MTCO<sub>2</sub> emissions) may be avoided (Taha et al.).

#### **4. Potential Emission Reductions**

As the proposed strategy consists of voluntary guidance, estimating the emission reductions is a function of the actual strategies employed as well as the magnitude of adoption. As such, potential emission reduction estimates are to be determined as part of the development of the guidelines.

#### **5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities**

Developing effective guidelines will also increase energy independence, reduce peak energy that is quite often highly polluting, have air pollution benefits through reductions in precursors to ozone and particulate matter, and offer impetus to gentrification and increases in real estate values (Thériault et al. (2005)). Application of the guidance would likely increase construction costs in California. Rise of a new California-specific construction sector would however be a significant boon to our economy. Small businesses have the flexibility of becoming a part of this new expertise construction sector. Environmental justice communities would benefit from gentrification and increases in real estate value. Significant funding from point sources, local and state governments, and the public sector could be expected.

## 6. Technical Feasibility

Cool roofs are already a part of Title 24, and urban forestry has long been recognized a key to energy conservation and urban gentrification, thus, these technologies are feasible and proven.

## 7. Additional Considerations

**Affected Entities:** Construction permit jurisdictions, state and local governments, construction industry

**Trade Associations:** Construction industry associations

**Government Agencies to coordinate with:** California Energy Commission & LBNL

**8. Division:** Research Division  
**Staff Lead:** Ash Lashgari  
**Section Manager:** Eileen McCauley  
**Branch Chief:** TBD

## 9. References

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<http://www.census.gov/acs/www/Products/Profiles/Single/2003/ACS/Tabular/040/04000US063.htm>

# Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

## 1. Early Actions Strategy Name and Proponent

SUMMARY #            *B33*  
ID NUMBER:         *SCAQMD-4*  
TITLE:                *STRENGTHEN LIGHT-DUTY VEHICLE STANDARDS*  
PROONENT:         *SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT*

## 2. Staff Recommendation

This measure was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, no change in the classification of this measure is recommended. The Board date for consideration of this item is anticipated in 4<sup>th</sup> quarter of 2012.

In September 2004 the California Air Resources Board approved regulations to reduce greenhouse gas emissions from new motor vehicles. The regulations apply to new passenger vehicles and light duty trucks beginning with the 2009 model year. The standards adopted by the Board phase in during the 2009 through 2016 model years. When fully phased in, the near term (2009-2012) standards will result in about a 22 percent reduction as compared to the 2002 fleet, and the mid-term (2013-2016) standards will result in about a 30 percent reduction.

The proposed strategy is the second phase of the 2004 regulation. This timing of 2012 will allow staff the time necessary to complete inventory research, interagency coordination, economic analyses, staff reports, stakeholder workshops, and public hearings to support the necessary regulation(s).

## 3. Early Action Description

Adopt new standards to phase in beginning in the 2017 model year (following up on the existing mid-term standards that reach maximum stringency in 2016). The technologies that might be employed include highly efficient hybrid vehicles, use of lightweight materials to reduce vehicle mass, and reductions in air conditioning related emissions through the use of cool paints, low-GWP refrigerants, or other approaches.

## 4. Potential Emission Reductions

The currently adopted standards call for about a 30 percent reduction of GHGs by 2016. Assuming that the new standards call for about a 50 percent reduction, phased in beginning in 2017, this measure would achieve about a 4 MMT reduction in 2020. The reduction achieved by this measure would significantly increase in subsequent years as clean new vehicles replace older vehicles in the fleet—staff estimates a 2030 reduction of about 27 MMT.

## 5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

Not yet determined.

## 6. Technical Feasibility

The technologies involved in this strategy are either being proved or showing promising technical feasibility. For example, available technologies that could be widely used on light-duty vehicles by 2012 include:

- Variable valve timing & lift
- Cylinder de-activation
- Gasoline direct injection - stoichiometric
- Turbocharging or cylinder deactivation
- 6-speed automatic and automated manual transmission
- Electric power steering
- Improved alternator
- More efficient, low-leak air conditioning
- Improved aerodynamics
- E85 vehicles

Additional technologies that could be widely used by 2016

- Extensive use of E85 vehicles
- Homogenous Combustion Compression Ignition (HCCI)
- Integrated Starter Generators (ISG)
- Camless Valve Actuation (CVA)
- Diesels
- Hybrids

## 7. Additional Considerations

In the near term, staff will continue to evaluate emerging technologies that have the potential to provide additional greenhouse gas reductions. Some technologies discussed under this subject can be implemented via separated early actions. Please refer to this report for detailed discussion.

**8. Division:** Mobile Source Control Division  
**Staff Lead:** TBD  
**Section Manager:** TBD  
**Branch Chief:** TBD

## 9. References:

*Work Plan for Potential GHG Reduction Measure, Air Resources Board 2-1.*

# Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

## 1. Early Actions Strategy Name and Proponent

SUMMARY #            *B34*  
ID NUMBER:         *SCAQMD-5*  
TITLE:                *OFF HIGHWAY RECREATIONAL VEHICLE (OHRV)  
EVAPORATIVE EMISSIONS CONTROL*  
PROPONENT:        *2007 STATE IMPLEMENTATION PLAN AND SOUTH COAST  
AIR QUALITY MANAGEMENT DISTRICT*

## 2. Staff Recommendation

Staff recommends that this measure not be listed as an early action. Staff is aware of the potential climate benefit from hydrocarbon emission reductions, but additional developments are needed to address remaining scientific uncertainties regarding their climate impacts. Staff recommends that ARB continue to track the subject and further evaluation be conducted as appropriate. The strategy will remain on track for its air quality benefits.

## 3. Early Action Description

The OHRV category includes off highway motorcycles, ATVs, sand cars, and specialty vehicles. The OHRV evaporative emissions regulation will control primarily hydrocarbon emissions. Hydrocarbons are ozone precursors and ozone is a greenhouse gas. OHRVs will use proven automotive control technology including:

- Low Permeation Fuel Lines
- Low Permeation Fuel Tanks
- Carbon Canisters
- Fuel Injection

Additionally ARB will evaluate two implementation approaches:

1. A performance standard that will require equipment to be tested and meet a certain emission standard.
2. A design standard that will require equipment to use certified components. Each component must be tested and meet a certain emission standard.

## 4. Potential Emission Reduction

The OHRV regulation is expected to be implemented in 2012. When fully implemented in 2020, hydrocarbons are projected to be reduced by 11.3 TPD<sup>1,2</sup>. A reduction of hydrocarbon emissions will lead to a reduction in ozone. However, currently there is no model that projects the CO<sub>2</sub>-equivalent warming impact for hydrocarbon emissions.

## 5. Estimated Cost / Economic Impacts and Impacted Sectors / Entities

An initial staff estimate of the increased cost to consumers to purchase an OHRV with evaporative controls is \$350. It is expected that OHRV manufacturers will pass the cost of the regulation onto the OHRV consumer. When fully implemented in 2020 the total cost will be \$588 million<sup>3</sup>. OHRV dealers may be adversely affected by an increase in equipment price of OHRVs.

## 6. Technical Feasibility

Potential technology that will control hydrocarbon emissions from OHRVs includes low permeation fuel tanks, low permeation fuel lines, carbon canisters, and fuel injection. These types of control technology have been proven on on-road vehicles for over 25 years. Recently evaporative controls have also been required on off-road categories such as land and garden equipment.

## 7. Additional Considerations

Currently ARB has aligned its regulatory approach with a U.S. EPA regulation that sets permeation standards for fuel tanks and fuel lines. However, ARB's OHRV regulatory initiative will evaluate the stringency of those standards to see if they can be tightened. ARB will also seek emission reductions from other sources within the category such as carburetors and running losses.

|                         |                                    |
|-------------------------|------------------------------------|
| <b>8. Division:</b>     | Monitoring and Laboratory Division |
| <b>Staff Lead:</b>      | Pippin Mader                       |
| <b>Section Manager:</b> | James Watson                       |
| <b>Branch Chief:</b>    | Manjit Ahuja                       |

## 9. References

<sup>1</sup> Full implementation assumed at 95%

<sup>2</sup> All emission calculations based on ARB's Off-road 2007 Model and 75% control

<sup>3</sup> Controlled population of ~1.68 million in 2020 times \$350

# Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

## 2. Early Actions Strategy Name and Proponent

SUMMARY #            *B35*  
ID NUMBER:         *SCAQMD-5*  
TITLE:                *DETERMINATION OF EVAPORATIVE EMISSIONS FROM PLEASURE CRAFT*  
PROPONENT:        *2007 STATE IMPLEMENTATION PLAN AND SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT*

## 2. Staff Recommendation

Staff recommends that this measure not be listed as an early action. Staff is aware of the potential climate benefit from hydrocarbon emission reductions, but additional developments are needed to address remaining scientific uncertainties regarding their climate impacts. Staff recommends that ARB continue to track the subject and further evaluation be conducted as appropriate. The strategy will remain on track for its air quality benefits.

## 3. Early Action Description.

The Pleasure Craft category includes inboard, outboard, sterndrive, and personal watercraft. The Pleasure Craft evaporative emissions control regulation will reduce hydrocarbon emissions. Hydrocarbons are ozone precursors and ozone is a greenhouse gas. Pleasure Craft will use proven automotive control technology including:

- Low Permeation Fuel Lines
- Low Permeation Fuel Tanks
- Carbon Canisters
- Fuel Injection

## 4. Potential Emission Reduction

The Pleasure Craft regulation is expected to be implemented in 2012. Hydrocarbon emissions are projected to be reduced by 16 TPD in 2012. When fully implemented in 2035<sup>1,2</sup>, hydrocarbons are projected to be reduced by 53 TPD. However, currently there is no model that projects the CO<sub>2</sub>-equivalent warming impact for hydrocarbon emissions.

## 5. Estimated Cost / Economic Impacts and Impacted Sectors / Entities

An initial staff estimate of the increased cost to consumers to purchase a boat with an evaporative control system is \$350<sup>3</sup>. The estimated increased cost is minimal when

compared to the current cost of a new boat. When partially implemented in 2020, the cost to consumers is projected to be \$310 million. When fully implemented in 2035 the total cost to consumers is estimated at \$1.13 billion<sup>4</sup>. There is no foreseeable adverse impact on any businesses or individuals.

## **6. Technical Feasibility**

Potential control technology that will reduce hydrocarbon emissions from Pleasure Craft includes low permeation fuel tanks, low permeation fuel lines, carbon canisters, and fuel injection. These types of control technology have been proven on on-road vehicles for over 25 years. Recently evaporative controls have also been required on off-road categories such as land and garden equipment. Furthermore, a 2005 in-use study of Pleasure Craft retrofitted with carbon canisters conducted by the National Marine Manufacturers Association demonstrated technical feasibility for marine applications and lessened boat manufacturer concerns.

## **7. Additional Considerations**

The proposal being developed does not seek to retrofit existing boats with control technology due to cost and safety issues. Because of their lengthy useful life, it may take up to three decades for the inventory of Pleasure Craft to become fully compliant subsequent to implementation of the regulation 2012.

**8. Division:** Monitoring and Laboratory Division  
**Staff Lead:** Fredrick Burriell  
**Section Manager:** James Watson  
**Branch Chief:** Manjit Ahuja

## **9. References**

<sup>1</sup> Full implementation assumed at 95%

<sup>2</sup> All emission calculations based on ARB's Off-road 2007 Model and 70% control reduction

<sup>3</sup> Cost estimates based on a per vehicle control technology cost of \$350

<sup>4</sup> Controlled population of ~3.22 million in 2035 times \$350.

# Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

## 1. Early Actions Strategy Name and Proponent

SUMMARY #            *B36*  
ID NUMBER:         *EA 3-3*  
TITLE:                *VESSEL SPEED REDUCTION*  
PROPONENT:        *AIR RESOURCES BOARD*

## 2. Staff Recommendation

This measure was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, no change in the classification of this measure is recommended. At this time, staff is evaluating whether this is most appropriately managed as a regulatory item or a voluntary measure.

The staff recommends retaining the vessel speed reduction (VSR) measure as an early action for the following reasons:

- the need to gather additional information on the scope, emissions impact, cost, and environmental impacts of the measure; and
- the need for stakeholder input on whether a voluntary or regulatory approach should be taken.

Based on preliminary emissions estimates, the overall weight of evidence suggests that this measure would fall under the medium category for regulatory action (see subsection 4 for emission benefits).

## 3. Action Description

As part of our efforts under the Diesel Risk Reduction Plan, Goods Movement Emissions Reduction Plan, and Assembly Bill 32 - Greenhouse Gas Initiative, the Air Resources Board (ARB) staff is evaluating the need to develop an ocean-going VSR program. Ocean-going VSR is primarily a measure designed to reduce oxides of nitrogen (NOx) emissions, but also provides reductions in diesel PM emissions, oxides of sulfur (SOx) emissions, and carbon dioxide (CO<sub>2</sub>) emissions.

Over the past six years, a VSR program has been in place at the Port of Los Angeles and Port of Long Beach (POLA/POLB). The program requests that vessels reduce their speed to 12 knots beginning 20 nautical miles (nm) off shore from the POLA/POLB. Currently, the POLB maintains a Green Flag Program which is an incentive program that offers reduced dockage fees for those vessels in compliance with VSR. The compliance rate for the POLB Green Flag Program is about 80 percent.

ARB staff has begun a technical assessment of the impacts associated with VSR for ocean-going vessels. As part of the technical assessment, staff will be evaluating

emission reduction benefits of a VSR measure in and out of California ports and along the California coast within 24 nm, 40 nm, and 100 nm.

The staff assessment is in its very early stages. ARB staff held its first VSR workshop on July 12, 2007. At this workshop, ARB staff presented an overview of their activities related to the VSR assessment and shared some key elements needing industry's assistance. To conduct a full evaluation, ARB staff is in need of additional data to refine our emissions inventory, such as emission factors, speed data from ports other than POLA/POLB, as well as, an understanding of the operating cost impacts to the industry. ARB staff expects to release a draft technical assessment report with the results of their evaluation by the end of 2007. The evaluation in this report will be key to determining the need and best approach to implement a regulatory or a voluntary VSR measure.

#### **4. Potential Emission Reductions**

VSR is primarily a measure designed to reduce NO<sub>x</sub> emissions, but also provides reductions in diesel PM emissions, SO<sub>x</sub> emissions, and CO<sub>2</sub> emissions. ARB staff has estimated the potential emissions reductions as a result of implementing a statewide VSR program within 24 nm and 100 nm of the California coastline. This preliminary assessment is based on the emissions benefits estimated using emissions factors from the use of low sulfur (0.1%) marine distillate in marine main and auxiliary engines and 2006 port call data from the California State Lands Commission. Our preliminary assessment suggests that the implementation of VSR reduces pollutants such as NO<sub>x</sub>, diesel PM, and SO<sub>x</sub> by an average of 30 percent within 24 nm of the California coast. In addition to these criteria pollutant emission reduction benefits, if a VSR program is implemented at 24 nm, the potential CO<sub>2</sub> emission reductions in 2010 are estimated to be 0.62 million metric tons of CO<sub>2</sub> (MMTCO<sub>2</sub>) and increasing to 0.97 MMTCO<sub>2</sub> by 2020. If a VSR measure was implemented at a distance of 100 nm, then the additional CO<sub>2</sub> emission reductions in 2010 are estimated to be approximately 0.5 MMTCO<sub>2</sub> and in 2020 approximately 0.83 MMTCO<sub>2</sub>. These estimates exclude the emissions benefits already achieved by the POLA/POLB at a compliance rate of about 80 percent.

A VSR program at other ports, such as San Diego and Hueneme, may also provide emissions benefits, and to a lesser extent, San Francisco Bay Area ports. It is questionable whether a coastline VSR measure will achieve significant emission benefits.

The CO<sub>2</sub> emission reduction potential rating for a VSR measure within 24 nm of the California coast is estimated to be in the medium (>0.1 to 1.0 MMTCO<sub>2</sub>) category.

#### **5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities**

The estimated costs and economic impacts of a regulatory or voluntary VSR measure have not been evaluated. A cost impact analysis for either a regulatory or voluntary VSR measure would need to include an estimate of the increase in the cost of operation to shipping companies due to reducing speeds in and out of California ports and along the coastline, increase cost of fuel used in auxiliary engines due to increased time traveling to port versus the fuel savings due to decreased ship engine power requirements, costs borne by the industries/terminals affected by a VSR measure, costs to ports in developing infrastructure improvements (i.e., radar equipment), and costs needed for enforcing any speed reduction measure. In addition to the POLA/POLB, staff is currently evaluating other major ports such as those in the Bay Area, San Diego, and

Hueneme. Staff is also looking at the impact to the industry if VSR was implemented while transiting along the California coastline within 24 nm and 100 nm.

Voluntary measures, such as seen in the POLB Green Flag Incentive Program, may require port and terminal-specific costs. Some of the incentives of this program include reduced dock fees for those complying with the VSR program and tariff reduction incentives. The San Pedro Bay Clean Air Action Plan adopted in 2006 for the POLA/POLB, have estimated the costs of controls for the voluntary VSR measure to be approximately 4.4 million dollars for 2010. The POLA/POLB has already committed to fund a maximum of 11.3 million dollars through 2010/2011 for each port to implement the port's Clean Air Action Plan.

## **6. Technical Feasibility**

A voluntary VSR program has been in place at the POLA/POLB over the past six years. The POLA/POLB accounts for over half of the port calls statewide. This VSR program requested ships to voluntarily reduce their speed to 12 knots at a distance of 20 nm from the California coast. Currently, the POLB maintains the Green Flag Incentive Program which offers reduced dockage fees and environmental awards for vessels that voluntarily reduce their speeds in and out of the POLB. This program has been very successful as shown by its current 80 percent compliance rate. A VSR program is clearly technologically feasible. However, reducing speeds for an extended period of time transiting along the coast has not been evaluated. There is some information that maintaining a slower speed for extended distances may cause adverse mechanical effects on a vessel's main engine. This analysis will need further evaluation.

## **7. Additional Considerations**

- With the exception of the voluntary programs at the POLA/POLB, no federal or other state VSR regulations are currently in place.
- VSR activity falls under ARB jurisdiction and legal authority. ARB's authority to regulate emissions beyond 3 nm is being challenged in court. Significant legal challenges are likely if the ARB elects to implement a VSR regulation beyond 24 nm.
- At this time, we are evaluating the feasibility of both regulatory and voluntary measures. Both approaches will consider speed reductions from direct travel in and out of major ports and evaluate the inclusion of transiting up and down the California coast. Voluntary approaches can include agreements or incentive programs between port and terminal operators, vessel owners and operators, and government agencies. Regulatory measures would take the form of an airborne toxic control measure.

**8. Division:** Stationary Source Division  
**Staff Lead:** Hafizur Chowdhury  
**Section Manager:** Robert Krieger  
**Branch Chief:** Dan Donohoue

# Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

## 1. Early Actions Strategy Name and Proponent

SUMMARY #            *B37*  
ID NUMBER:         *ENVIRO-2*  
TITLE:                *ANTI-IDLING ENFORCEMENT*  
PROPONENT:        *ENVIRONMENTAL STAKEHOLDERS*

## 2. Staff Recommendation

This measure is recommended for addition to the list of early actions. The Board date for consideration of this non-regulatory item would be the 4<sup>th</sup> quarter of 2008.

This strategy will ensure that climate change benefits are realized from an existing anti-idling rule. It is believed that the 0.7 million metric tons per year CO<sub>2</sub> reduction listed in the 2005 staff report for the anti-idling rule have not yet been claimed.

**Summary:** Restricting vehicle idling (in this case, heavy-duty commercial diesel vehicles) reduces the amount of fuel burned which in turn, causes fewer emissions of greenhouse gases. Staff recommends that this measure become an early action item for the following reasons:

- 1) An anti-idling regulation is currently in place;
- 2) An enhanced version of the current anti-idling regulation is slated to commence enforcement on January 1, 2008; and
- 3) Proposed legislation (Assembly Bill [AB] 233, Jones), if adopted, would authorize and require ARB to further enhance its enforcement of the anti-idling regulation. This bill calls for an enhanced enforcement plan to be adopted by the Board by January 1, 2009.

If this bill is not enacted, staff could include enforcement enhancements through a Board action directed at reviewing and amending the current anti-idling regulation (with Board hearing no sooner than 2011).

## 3. Early Action Description

The burning of diesel fuel contributes to greenhouse gas emissions. This strategy will reduce greenhouse gases by reducing the amount of fuel burned through unnecessary idling. AB 233 calls for adoption of an enhanced enforcement plan that would be heard by the Board as a non-regulatory item.

- 1) ARB adopted a diesel particulate air toxic control measure (Title 13 of the California Code of Regulations, Section 2485) in June 2004 to control idling of diesel-fueled commercial motor vehicles. Enforcement commenced the following year. This rule prohibits, with some exceptions, the idling of diesel-fueled commercial motor vehicles for more than five minutes, and applies to both trucks and buses greater than 10,000 lbs. gross vehicle weight. The measure also

prohibits operation of a diesel-fueled auxiliary power system for more than five minutes within 100 feet of individual or multi-family housing units. The penalty for violating the idling regulation is currently a minimum of \$100.

- 2) In October 2005, the Board approved an additional regulatory measure that eliminated the exemption for new and in-use trucks with sleeper berths starting in January 2008, thus requiring sleeper berth trucks to shut down and use alternative cab climate control technologies. In addition, the Board approved an amendment requiring that all new California-certified 2008 and subsequent model year heavy duty diesel engines be equipped with a non-programmable engine shutdown system that automatically turns off the engine after five minutes of idling. Enforcement of these provisions will begin in 2008.
- 3) AB 233, Jones, currently pending approval by the California Legislature, calls for:
  - a) Enhanced field enforcement of anti-idling and other ARB regulations. AB 233 would require ARB to review existing enforcement regulations and adopt a plan for enhanced and coordinated enforcement of these regulations by January 1, 2009. Implementation of the plan would address staffing needs, goals for inspection efforts, education and training. Increases in field enforcement would flush out additional violators and give them fewer opportunities to disobey the regulation.
  - b) Increased penalties for violations of anti-idling regulations. It is assumed that increasing the penalty from \$100 to \$300 per violation will increase the deterrent effect, resulting in improved compliance.
  - c) Restriction on registrations of heavy-duty diesel vehicles with uncorrected idling violations. This would serve as an additional enforcement tool to encourage compliance.

#### **4. Potential Emission Reductions**

The emission numbers in the tables below do not represent an additional benefit due to enhanced enforcement. Rather, the numbers show the benefits of 100% compliance with the existing anti-idling rule. Enhanced enforcement is necessary in order to achieve a high compliance rate.

The elimination of non-essential diesel fueled vehicle idling reduces greenhouse gases as reported in ARB's anti-idling program staff reports. According to ARB's Initial Statement of Reasons for Proposed Rulemaking dated September 2005, the proposed sleeper berth anti-idling regulation amendments alone will reduce CO<sub>2</sub> emissions by nearly 1,751 metric tons per day (MTPD) and 0.6 million metric tons per year (MTPY) in 2010, and 2,068 MTPD and 0.7 million MTPY in 2020. (See [www.arb.ca.gov/regact/hdvidle/isor.pdf](http://www.arb.ca.gov/regact/hdvidle/isor.pdf), page 46). Enhanced enforcement of these anti-idling regulations will reduce greenhouse gas emissions by ensuring that the intended benefit of 0.7 million MTPY is fully realized by 2020.

The tables below provide the estimated statewide emissions benefits projected in metric tons per year for the currently enforced anti-idling regulation and the sleeper berth exemption amendments to these regulations. However, these benefits assume 100% compliance. History has shown that no program achieves 100% compliance and that enhanced enforcement does lead to higher compliance rates. Based on a relatively small

sample of idling inspections, the current program's rate of compliance is approximately 95%. However, given the limited number of idling inspections (due to resource constraints), it is assumed that this is not representative of statewide compliance rates.

**Estimated Statewide Idling Emission Benefits - Non-Sleeper Trucks (Metric Tons/Year) – Beginning in 2005**

|               | PM  | NO <sub>x</sub> | HC  | CO   | CO <sub>2</sub> |
|---------------|-----|-----------------|-----|------|-----------------|
| CA Registered | 151 | 4717            | 671 | 2631 | 312,344         |

Source: ARB's Initial Statement of Reasons for Proposed Rulemaking, July 22, 2004.

**2010 Estimated Statewide Idling Emission Benefits – Sleeper Trucks Only**

**Baseline Emissions (Metric Tons/Year) Calendar Year 2010**

|                              | Vehicles | NO <sub>x</sub> | ROG  | PM  | CO <sub>2</sub> |
|------------------------------|----------|-----------------|------|-----|-----------------|
| CA Registered Sleeper Trucks | 30,161   | 6570            | 694  | 128 | 397,485         |
| Out-of-State Sleeper Trucks  | 45,241   | 10,950          | 840  | 113 | 596,045         |
| Total Baseline               | 75,402   | 17,520          | 1533 | 241 | 993,530         |

**Emission Reductions (Metric Tons/Year) Calendar Year 2010**

|                              | Vehicles | NO <sub>x</sub> | ROG  | PM  | CO <sub>2</sub> |
|------------------------------|----------|-----------------|------|-----|-----------------|
| CA Registered Sleeper Trucks | 30,161   | 5475            | 621  | 88  | 255,135         |
| Out-of-State Sleeper Trucks  | 45,241   | 9490            | 730  | 55  | 383,980         |
| Total Baseline               | 75,402   | 15,330          | 1387 | 139 | 639,115         |

**2020 Estimated Statewide Idling Emission Benefits – Sleeper Trucks Only**

**Baseline Emissions (Metric Tons/Year) Calendar Year 2020**

|                              | Vehicles | NO <sub>x</sub> | ROG  | PM | CO <sub>2</sub> |
|------------------------------|----------|-----------------|------|----|-----------------|
| CA Registered Sleeper Trucks | 35,652   | 8760            | 657  | 55 | 470,120         |
| Out-of-State Sleeper Trucks  | 53,478   | 12,775          | 913  | 26 | 705,180         |
| Total Baseline               | 89,130   | 21,535          | 1606 | 81 | 1.18M           |

**Emission Reductions (Metric Tons/Year) - Calendar Year 2020**

|                              | Vehicles | NO <sub>x</sub> | ROG  | PM  | CO <sub>2</sub> |
|------------------------------|----------|-----------------|------|-----|-----------------|
| CA Registered Sleeper Trucks | 35,652   | 7300            | 584  | 26  | 301,490         |
| Out-of-State Sleeper Trucks  | 53,478   | 11,315          | 876  | 7.3 | 453,695         |
| Total Baseline               | 89,130   | 18,615          | 1460 | 33  | 754,820         |

Source: ARB's Initial Statement of Reasons for Proposed Rulemaking, September 1, 2005

## 5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

The current anti-idling regulations provide for savings of approximately \$100 million per year in reduced fuel and maintenance costs. The sleeper berth exemption amendments to these regulations provide an additional annual savings of approximately \$20 million per year in reduced fuel and maintenance costs. The sleeper berth exemption also is projected to save approximately 70 million gallons of diesel fuel per year.

To comply with the sleeper berth exemption amendments, vehicle owners may spend between \$1,000 and \$10,500 depending on the type of alternative power selected and the application needed. However, it is expected that vehicle owners will recover their initial investments over time through the fuel and maintenance savings discussed above. Although ARB estimates cost recovery times to range between 8 months and 3 years, actual recovery times will solely depend on the alternative(s) selected and the amount of time spent at idle. Financial incentives may be available for qualified zero-emissions technologies through the Carl Moyer Program.

Costs to State – If enhanced enforcement is to be achieved, additional resources will be necessary to increase enforcement presence.

## 6. Technical Feasibility

Technologies that will allow vehicle operators to maintain cab comfort while not running the vehicle's main engine are currently available. Some of these technologies are diesel-fueled auxiliary power systems, fuel-fired heaters, battery-electric auxiliary power systems, vehicle-battery-powered systems, truck stop electrification (on-board and off-board power infrastructure), and thermal energy storage systems.

## 7. Additional Considerations

A number of states have similar laws and some are more stringent than California's current law. However in 2008, California's law will no longer exempt idling of a vehicle's main engine while the operator sleeps in a sleeper berth.

This existing rule can be enforced by ARB staff, as well as by peace officers and air district personnel. This strategy is not a regulatory item. If AB 233 is approved, it calls for ARB to adopt a comprehensive enforcement plan by January 1, 2009.

AB 233 has not yet been approved (as of August 15, 2007).

|                         |                      |
|-------------------------|----------------------|
| <b>8. Division:</b>     | Enforcement Division |
| <b>Staff Lead:</b>      | Nancy O'Connor       |
| <b>Section Manager:</b> | Judy Lewis           |
| <b>Branch Chief:</b>    | Paul E. Jacobs       |

## 9. References:

*Assembly Bill 233 of 2007, Jones.*

*Senate Transportation & Housing Committee Analysis of AB 233, June 1, 2007.*

ARB webpage: <http://www.arb.ca.gov/msprog/truck-idling/truck-idling.htm>

ARB webpage: <http://www.arb.ca.gov/regact/hdvidle/isor.pdf>

# Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

## 1. Early Actions Strategy Name and Proponent

SUMMARY #            *B38*  
ID NUMBER:         *ARB 4-4*  
TITLE:                *SF<sub>6</sub> REDUCTIONS FROM THE NON-ELECTRIC SECTOR*  
PROPONENT:        *STAKEHOLDER SUGGESTION*

## 2. Staff Recommendation

This measure is recommended for addition to the list of discrete early actions. The Board date for consideration of this item is anticipated in 1<sup>st</sup> quarter of 2009.

The staff recommends developing regulations that ban the use of sulfur hexafluoride (SF<sub>6</sub>) for non-electricity sector/semiconductor applications where technologically feasible and cost-effective alternatives are available. As part of the assessment, strategies for achieving voluntary reductions will also be evaluated.

## 3. Early Action Description

This strategy applies to uses of SF<sub>6</sub> other than the electrical utility industry and the semiconductor industry, which will be evaluated under separate strategies. The largest non-utility industry, non-semiconductor industry uses of SF<sub>6</sub> identified by the staff to date include the magnesium manufacturing and casting operations, air quality tracer studies, and a gas for testing laboratory hoods to ensure worker safety and that Cal-OSHA ventilation requirements are met. Other uses cited include accelerators, leak detection, optical fiber production, glazing, medical, and refining, but the extent of these uses in California is currently unknown. The staff plans to identify all of the uses of SF<sub>6</sub> in California, and the amount used, as part of its evaluation. As part of the regulatory development process, the staff will assess other uses of SF<sub>6</sub>, the associated emissions, mitigation options as well as cost to determine whether action is warranted. The U.S. EPA has formed a "Magnesium Industry Partnership" to voluntarily phase-out the use of SF<sub>6</sub> in the magnesium industry by the end of 2010, so a regulation of this industry may be unnecessary. Nationwide, emissions from the magnesium industry are about 2.7 MMTCO<sub>2</sub>E per year. There are currently only three companies in California that have magnesium production and casting operations and that are members of the EPA partnership. The SF<sub>6</sub> emissions from these companies are currently unknown. But scaling the nationwide estimated of 2.7 MMTCO<sub>2</sub>E per year to California by the number of production facilities gives a California number of about 0.09 MMTCO<sub>2</sub>E per year.

The staff envisions banning the use of SF<sub>6</sub> in non-utility, non-semiconductor applications where safe, cost-effective alternatives are available. These applications may include magnesium production and casting operations, air quality tracer gas studies, and ventilation tests for laboratory hoods. The staff will investigate other possible uses of

SF<sub>6</sub> during the development of the regulations. It is important that all uses of SF<sub>6</sub> be investigated and considered given its high GWP, particularly if the application is one in which the compound is deliberately emitted, such as tracer gas applications. One pound of SF<sub>6</sub> emitted is equivalent to about 10 metric tons of carbon dioxide, from a global warming perspective.

#### **4. Potential Emission Reductions**

##### **Statewide Emission Inventory**

2020 GHG Emission Inventory: It is estimated that, nationwide, about 10 percent of the total SF<sub>6</sub> is used in applications other than the utility and semi-conductor industries. It is also estimated that about half of this 10 percent is used in the magnesium industry. The most recent estimate of emissions in California from both electric utilities and semiconductor manufacturing operations is about 1.6 MMTCO<sub>2</sub>E per year (CEC, 2006). Assuming that the proportion of SF<sub>6</sub> emitted to the amount of SF<sub>6</sub> used in other applications is the same as that for the utility and semiconductor applications, emissions from the other applications would be about 0.18 MMTCO<sub>2</sub>E per year in California. Nationwide, SF<sub>6</sub> emissions from the magnesium industry are currently about 2.7 MMTCO<sub>2</sub>E per year. Scaling this number down to the number of production facilities in California gives a California emission estimate of about 0.09 MMTCO<sub>2</sub>E per year. However, if the U.S. EPA Magnesium Industry Partnership is successful in phasing out the use of SF<sub>6</sub> by the end of 2010, the emissions from the magnesium industry will be zero in 2020. This leaves at least 0.09 MMTCO<sub>2</sub>E per year from other applications such as tracer studies and laboratory hood tests. However, it is likely that emissions from these other applications are somewhat higher than 0.09 MMTCO<sub>2</sub>E per year due to the fact that the ratio of amount of gas emitted to amount used in these applications is higher than that for utilities. In the utilities, the gas is emitted gradually as it escapes from enclosed systems, while in tracer studies and hood tests it is emitted instantaneously.

**Anticipated 2020 Reductions:** It is anticipated that all, or nearly all, of the emissions from non-utility, non-semiconductor use would be eliminated under the staff proposal. Therefore, the reductions are estimated to be on the order of 0.1-0.2 MMTCO<sub>2</sub>E per year.

#### **5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities**

Alternative gases have been identified for magnesium production and casting operations, and for laboratory hood tests performed to ensure adequate ventilation rates. The cost and economic impacts of using these gases will be evaluated during the regulatory development process, but the difference in cost would be expected to be modest.

#### **6. Technical Feasibility**

As part of the U.S. EPA's Magnesium Industry Partnership, magnesium production and casting operations have been developing the use of gases other than SF<sub>6</sub> to provide the

cover gas protection provided by SF<sub>6</sub>. The partnership is attempting to meet the goal of phasing out SF<sub>6</sub> by 2010.

The staff will investigate both the technical and economic feasibility of using alternative gases in air quality tracer studies and laboratory hood tests done to comply with Cal-OSHA ventilation standards. The technical and economic feasibility of using alternative gases will also be evaluated for any other use of SF<sub>6</sub> identified by the staff.

## 7. Additional Considerations

Some of the factors that will need to be carefully evaluated include determining if there are alternative gases as safe and effective as SF<sub>6</sub> with lower lifecycle GHG emissions. To the extent that alternatives are available, staff would also investigate whether a voluntary measure such as a voluntary phase-out program would be as effective as a regulatory approach.

**Affected Entities:** Companies that produce magnesium or magnesium castings, air pollution and air quality researchers, universities, industries, and other institutions that have laboratory hoods that are subject to Cal-OSHA standards.

**Trade Associations:** North American Die Casting Association (DADCA), Compressed Gas Association, Associations which include industrial hygienists. American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE).

**Government Agencies to coordinate with:** U.S. EPA, Cal-OSHA

**Proposed Board Hearing Date:** January, 2009

**8. Division:** Research Division  
**Staff Lead:** Kevin Cleary  
Greenhouse Gas Technology and Field Testing  
**Section Manager:** Mike FitzGibbon  
**Branch Chief:** TBD

## 9. References:

*Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2005, United States Environmental Protection Agency, April 15, 2007*

*Inventory of California Greenhouse Gas Emissions and Sinks: 1990-2004, California Energy Commission, December, 2006*

*Communications with Cal-OSHA staff (Mike Horowitz)*

*Nationwide SF<sub>6</sub> Sales by End Use: 1961-2003, Fourth International Conference on SF<sub>6</sub> and the Environment, November, 2006, the Rand Corporation*

# Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

## 1. Early Actions Strategy Name and Proponent

SUMMARY #            *B39*  
ID NUMBER:         *N/A*  
TITLE:                *REDUCTION OF HIGH GWP GHGs USED IN CONSUMER PRODUCTS*  
PROPONENT:        *AIR RESOURCES BOARD STAFF*

## 2. Staff Recommendation

This measure is recommended for addition to the list of discrete early actions. The Board date for consideration of this item is anticipated in 4<sup>th</sup> quarter of 2008.

Some data regarding emissions of greenhouse gases is available from a recent survey of consumer products, which may represent possible reductions within the discrete early action timeframe. Manufacturers are also currently being surveyed to determine the extent of usage of high global warming potential (GWP) gases in several more categories of consumer products. These future survey results may lead to additional strategies with emission reduction potential that can be pursued after the deadline for discrete early action items.

## 3. Early Action Description

Consumer product formulations may be modified to reduce or eliminate the use of greenhouse gases with high GWP. Gases of interest include HFCs, HCFCs, HFEs, carbon dioxide, and nitrogen oxides, which are used as propellants in tire inflators, electronics cleaners, dust removal products, hand held sirens, hobby guns (compressed gas), party products (foam string), and other formulated consumer products. The objective of this discrete early action strategy would be to reduce the impact of high GWP GHGs used in these products when alternative formulations are available. For example, one possible form of the strategy would be to require switching when feasible from using a high GWP GHG such as HFC-134a (GWP=1300) to a GHG with a lower GWP such as HFC-152a (GWP=120). The Consumer Products Program is implemented through regulations and this proposed new discrete early action strategy would occur as part of that regulatory process.

## 4. Potential Emission Reductions

ARB staff estimate a potential emissions reduction of up to 0.25 MMTCO<sub>2</sub>E from consumer products. ARB is currently surveying consumer product manufacturers for specific information on product ingredients. Categories listed above that may contain high GWP GHGs are included in the survey. The required submission date for the survey is November 21, 2007. Analysis of survey data will provide an accurate estimate of potential emission reductions.

In 2002, A. D. Little reported that the annual North American consumption and emissions of HFCs in consumer products was 10 MMTCO<sub>2</sub>E with the two highest-use products being dust removal products and tire inflators at 4.7 and 3 MMTCO<sub>2</sub>E, respectively. California's population is about eight percent of the North American population. Assuming product usage is similar across North America and scaling with population, HFC emissions from consumer products in California are about 0.8 MMTCO<sub>2</sub>E. This value seems to be confirmed by initial results from ARB's 2003 Consumer and Commercial Products Survey.

## **5. Estimated Costs / Economic Impacts and the Impacted Sectors/ Entities**

Costs per MTCO<sub>2</sub>E are not available at this time. However, other regulations in the Consumer Products Program have been implemented in a cost effective manner. The manufacturers would bear the cost of formulation changes, then presumably pass the cost on to the consumer. Each product category would be fully evaluated for estimated costs as regulations are implemented. Any potential disproportionate impacts would depend on the individual product and whether it is used to a greater extent by any given sector of the population.

## **6. Technical Feasibility**

The ARB staff believes technology is available to make changes in some consumer product categories to decrease the use of high GWP GHGs without increasing other emissions. ARB has not previously worked with representatives of certain segments of the industry, such as manufacturers of hobby guns that use compressed gas, so determination of the technical feasibility of GHG reductions in some applications cannot be made at this time.

## **7. Additional Considerations**

Consumer Products are under ARB jurisdiction with legal authority for regulation. New regulations are scheduled to be heard by the Board in 2008. These regulations may address the use of high GWP GHGs in several product categories. An initial public meeting for the development of this regulation is scheduled for August 29, 2007. These regulations, already under development, will meet the statutory deadline for discrete early actions. Development of regulations for other categories of consumer products would fall under the Scoping Plan of The California Global Warming Solutions Act of 2006.

|                         |                            |
|-------------------------|----------------------------|
| <b>8. Division:</b>     | Stationary Source Division |
| <b>Staff Lead:</b>      | Jessica Dean               |
| <b>Section Manager:</b> | David Mallory              |
| <b>Branch Chief:</b>    | Janette Brooks             |

## **9. References:**

*Arthur D. Little, Global Comparative Analysis of HFC and Alternative Technologies for Refrigeration, Air Conditioning, Foam, Solvent, Aerosol Propellant, and Fire Protection Applications, Final Report to the Alliance for Responsible Atmospheric Policy, March 21, 2002*

# Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

## 1. Early Actions Strategy Name and Proponent

SUMMARY #            *B40*  
ID NUMBER:         *N/A*  
TITLE:                *COLLABORATIVE RESEARCH TO UNDERSTAND HOW TO  
REDUCE GREENHOUSE GAS EMISSIONS FROM NITROGEN  
LAND APPLICATION*  
PROPONENT:        *STAKEHOLDERS SUGGESTIONS*

## 2. Staff Recommendation

This measure is recommended for addition to the list of early actions. The Board date for consideration of this item is anticipated in 4<sup>th</sup> quarter of 2010.

## 3. Early Action Description

Staff analysis suggests that nitrogen land application may be a significant source of nitrous oxide, which is a potent greenhouse gas. In order to reduce greenhouse gases while benefiting agricultural systems, landscaping and other uses staff needs to identify methodologies for better characterizing California's nitrogen cycle.

An important first step to better characterizing the relationship between nitrogen land application and nitrous oxide formation in California agriculture, landscaping and other uses as well as opportunities for emission reductions is a collaborative research effort with stakeholders. The research is expected to focus on identifying optimal ways to reduce nitrous oxide emissions while increasing soil retention of nitrogen for plant uptake. Factors such as the total acreage of crop field, the annual amount and type of nitrogen applied, the method of application, soil properties, the irrigation regime, and drainage conditions can all play a role in characterizing nitrous oxide formation and would therefore be expected to be studied as part of the work. As part of the research the ARB will collaborate with the California Department of Food and Agriculture, Department of Pesticide Regulation, commodity groups, and other stakeholders. The research is expected to ultimately support the development of guidance to improve the characterization of nitrous oxide emissions from nitrogen land applications as well as identify effective strategies for emission reductions.

## 4. Potential Emission Reductions

The potential benefit of nitrous oxide emission reductions following from the research effort requires further assessment and is therefore to be determined. However, given the current nitrogen fertilizer use efficiency and portfolio, possible reductions from guidance that builds on the research may be on the order of 1 MMTCO<sub>2</sub>E.

## 5. Estimated Costs / Economic Impacts and the Impacted Sectors/ Entities

Entities expected to participate in the collaborative research effort as well as the subsequent development of guidance includes farm owners and operators, nitrogen fertilizer manufacturers and distributors, the California Department of Food and Agriculture, Department of Pesticide Regulation, Regional Water Boards, commodity groups, and other stakeholders. The estimated costs of the research are to be determined as are any costs or savings associated with implementing subsequent guidance.

## 6. Technical Feasibility

The ARB has an established track record of collaborating with stakeholders to ensure that high quality research is conducted and that the research facilitates the identification of effective mitigation strategies. It is anticipated that the necessary expertise to conduct the research can be secured via a contract with in-state experts.

## 7. Additional Considerations

The ARB will coordinate with the California Department of Food and Agriculture, Regional Water Control Boards, and local air quality management districts in their efforts related to Nutrient Management Plans.

|                         |   |
|-------------------------|---|
| <b>8. Division:</b>     | Planning and Technical Support Division/Research Division |
| <b>Staff Lead:</b>      | TBD   |
| <b>Section Manager:</b> | TBD   |
| <b>Branch Chief:</b>    | TBD   |

## 9. References:

Blaylock, A.D., R. D. Dowbenko, J. Kaufmann, G. D. Binford, and R. Islam. 2004. ESN® controlled-release nitrogen for enhanced nitrogen efficiency and improved environmental safety. Picogram and Abstracts, America Chemical Society, Philadelphia, PA.  
<http://membership.acs.org/a/agro/Picogram/PicogramV67Fall2004.pdf>

Brontrager, B. 2001. Stretch your 'N' dollars using urease, nitrification inhibitors.  
<http://www.agprofessional.com/croptalk.php?id=1135>

Burt, C. M., K. OConnor, and T.A. Ruehr. 1995. Fertigation. pp. 320Irrigation Training and Research Center. California Polytechnic State University, San Luis Obispo, CA.

Li, C.S., W. Salas, and M. L. Huertos. 2004. Quantifying carbon dynamics and greenhouse gas emissions in agricultural soils of California: A scoping study. PIER Project Report, P500-04-038. California Energy Commission, Sacramento, California.  
[http://www.climatechange.ca.gov/research/options/pdfs/2004-10-08\\_500-04-038.pdf](http://www.climatechange.ca.gov/research/options/pdfs/2004-10-08_500-04-038.pdf).

Scholefield, D. and N.M. Titchen. 1995. Development of a rapid field test for soil mineral nitrogen and its application to grazed grassland. *Soil Use and Management* 11 (1), 33–43.

**APPENDIX C – Staff Evaluation of Remaining  
Previously Approved Early Actions**

| <b>SUMMARY ID</b> | <b>SUMMARY TITLE</b>   | <b>PAGE NUMBER</b> |
|-------------------|--|--------------------|
| Appendix C01      | Stationary agricultural engine electrification                                     | C- 3               |
| Appendix C02      | Reduction of perfluorocarbons (PFCs) from the semiconductor industry               | C- 5               |
| Appendix C03      | Foam recovery / destruction program  | C- 8               |
| Appendix C04      | Guidance and protocols for local governments to facilitate GHG emission reductions | C- 12              |
| Appendix C05      | Guidance/protocols for businesses to facilitate GHG emission reductions            | C- 15              |
| Appendix C06      | Reduce sulfur hexafluoride (SF6) from electrical generation                        | C- 18              |
| Appendix C07      | Alternative suppressants in fire protection systems                                | C- 20              |
| Appendix C08      | Forestry protocol endorsement  | C- 23              |
| Appendix C09      | Enforcement of federal ban on HFC release during service/dismantling of MVACs      | C- 26              |

# Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

## 1. Early Actions Strategy Name and Proponent

SUMMARY #            *C01*  
ID NUMBER:            *ARB 2-2*  
TITLE:                 *STATIONARY AGRICULTURAL ENGINE ELECTRIFICATION*  
PROPONENT:            *AIR RESOURCES BOARD STAFF*

## 2. Staff Recommendation

This strategy was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, no change in the classification of this strategy is recommended.

However, given that electrification of stationary agricultural diesel engines must be considered on a case-by-case basis due to operational and cost issues, a control measure to require the electrification of these engines is impractical and cost-prohibitive for many growers (see Parts 5 and 7 for additional information). Accordingly, the approach currently being implemented is an outreach effort and therefore a Board hearing is not anticipated.

## 3. Early Action Description

As part of the outreach being conducted for the amendments to the airborne toxic control measure (ATCM) for Stationary Compression-Ignition Engines, ARB staff is working with the local air districts to encourage replacement of diesel engines with electric motors and to take advantage of incentive funding opportunities. Outreach materials and workshops will provide information regarding ATCM compliance options, including electrification. ARB staff is encouraging growers to consider switching to electric motors, especially in those cases where irrigation pumps are located in close proximity to residential areas, schools, and hospitals.

## 4. Potential Emission Reductions

This effort is expected to have a low emission reduction potential. Based on discussions with the agricultural community and electric utilities, up to 20 percent of existing stationary diesel agricultural irrigation pump engines are expected to be replaced with electric motors by 2020. This would result in a 2020 reduction of approximately 0.1 million metric tons of carbon dioxide. Given the compliance schedule in the ATCM and uncertainty regarding some incentive programs, staff is unable to estimate reductions for 2010 at this time.

## 5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities

ARB staff estimates the cost to electrify stationary agricultural engines at about \$26 million (8,600 pump engines x 20 percent x \$15,000 (average capital cost of an electric motor)). This estimate does not account for possible additional line extension and/or electrical hook-up charges (highly variable for agricultural electric customers depending on location, crop,

well-depth, and other variables), which are likely to be cost prohibitive for many growers in remote areas. The estimate also does not account for any potential incentive funds that may be available to switch from diesel- to electric-powered agricultural irrigation pumps as these funds are limited and available on a first-come, first-served basis.

## **6. Technical Feasibility**

Outreach efforts will encourage the use of electric motors, which are established and proven in agricultural operations. Approximately 82 percent of all stationary agricultural irrigation pumps in California are currently powered by electric motors, 15 percent are diesel-powered, and three percent are powered by other means (e.g., natural gas, liquefied petroleum gas, propane, butane, or gasoline).

## **7. Additional Considerations**

The Board approved the amendments to the ATCM for Stationary Compression-Ignition Engines at the November 2006 public hearing. The amendments contain emission performance standards for agricultural engines but do not mandate electrification or any other specific compliance option. As explained in the September 2006 staff report for the ATCM, the Board had previously directed ARB staff to investigate the opportunities and challenges associated with replacing California's existing population of stationary diesel agricultural engines with electric motors. During the investigation, ARB staff identified many variables associated with farm and ranch electrical power use in California. These variables include irrigation method and schedule, availability of surface water, well pumping depth, quantity of water needed, fuel costs, electricity costs, and electrical infrastructure proximity and adequacy. Because of these variables, ARB staff concluded that any decision about the desirability or difficulty of converting stationary diesel agricultural engines to electric motors must be made on a site-by-site basis. Nonetheless, ARB staff believes that most engines will be replaced with new cleaner certified diesel engines or with electric motors. Retrofit and alternative fuels are other potential means of compliance. Staff is unable to predict which compliance option farmers will choose.

**8. Division:** Stationary Source Division  
**Staff Lead:** Jon Manji  
**Section Manager:** Richard Boyd  
**Branch Chief:** Dan Donohoue

# Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

## 1. Early Actions Strategy Name and Proponent

SUMMARY #            C02  
ID NUMBER:         ARB 2-4  
TITLE:                REDUCTION OF PERFLUOROCARBONS (PFCs) FROM THE  
                          SEMICONDUCTOR INDUSTRY  
PROPONENT:         AIR RESOURCES BOARD STAFF

## 2. Staff Recommendation

This measure was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, it is recommended that this measure be reclassified as a discrete early action. The Board date for consideration of this item is anticipated in 4<sup>th</sup> quarter of 2008.

## 3. Early Action Description

The semiconductor industry uses PFCs primarily for etching circuits in silicon wafers and cleaning chemical vapor deposition tool chambers where thin films of chemicals are laid down onto silicon wafers. During these processes, a portion of the PFC gases used is released to the atmosphere.<sup>1</sup> There are four technologies industry has either employed or considered to reduce PFC emissions from semiconductor production:

- Process Optimization (optimizing the use of PFCs, such as in the chamber cleaning process);
- Alternative Chemistry Development;
- Emission Abatement; and
- Recovery/Recycling (separation of fluorinated compounds from other gases for further processing and reuse).

This discrete early action item will consider mandating the process optimization and alternative chemistry development technologies currently in use by some manufacturers. ARB would also evaluate the technical and economic feasibility of requiring emissions abatement and recovery/recycling strategies that may further reduce PFC emissions.

A few California manufacturers currently participate in voluntary national efforts to reduce PFC emissions to 10 percent below 1995 levels by 2010. A 2001 Memorandum of Understanding (MOU) agreement with the U.S. EPA provides details of these efforts.<sup>2</sup> Only three of 93 California manufacturers (about 15 percent of California production) participate in the MOU agreement.<sup>3</sup> Manufacturers and the U.S. EPA reached the agreement well before the adoption of Assembly Bill 32. Consequently, the State and federal courses of action have different goals and timeframes and information on any actions being taken by the remaining California companies to reduce PFC emissions is limited. A survey of the industry will be necessary to improve the accuracy of the emissions data.

#### **4. Potential Emission Reductions**

ARB staff proposed a GHG reduction goal of 0.5 MMTCO<sub>2</sub> equivalent in 2020 for the semiconductor industry in the April 2007 early actions report.<sup>4</sup> This goal will be further evaluated based on survey results from the industry and other data that become available over the next few months.

#### **5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities**

The complete cost of this regulation has not been determined at this time. For process optimization, higher costs could be incurred by older fabrication facilities as process parameters such as chamber pressure, temperature, cleaning gas flow rates and gas mixture ratios are changed to reduce gas use. Alternative chemistry development is expected to result in minor cost impacts as the cost of alternative gases would be about the same as PFC gases. The manufacturers could pass on any additional costs to the consumers through higher product prices. The significance of this impact is not known.

#### **6. Technical Feasibility**

The technical feasibility of two of the four technology options for reducing PFC emissions within the semiconductor industry is fairly well known at this time. Two technologies currently used by manufacturers are:

- **Process optimization**  
This technology reduces the amount of PFCs used and has been primarily applied to the chamber cleaning process because of high use of PFC gases for cleaning.
- **Alternative Chemistry Development**  
Nitrogen trifluoride (NF<sub>3</sub>) has been used as a substitute for hexafluoroethane (C<sub>2</sub>F<sub>6</sub>) in the chamber cleaning process to reduce PFC emissions since NF<sub>3</sub> is more effectively destroyed in the process.

Two technologies that would be further evaluated are:

- **Emissions abatement**  
Commercially available technologies can be applied to the chamber cleaning or the etching process to reduce emissions. High temperature and catalytic oxidation and plasma destruction are the most common technologies used to abate PFCs, but little is currently known about the extent of use by California manufacturers. Furthermore, the performance of abatement systems can vary greatly depending on the abatement device and process parameters, such as temperature and PFC gas flow rates.
- **Recovery/Recycling**  
These technologies have not achieved as much success as others as they are more costly or require more maintenance. The recovered compounds that are separated from other gases contain more impurities than virgin chemicals and are less likely to be used by the industry.

## 7. Additional Considerations

Additional considerations that pertain to the measure include:

This item is regulatory and falls under ARB jurisdiction. ARB has the legal authority to pursue this discrete early action item and the Climate Action Team supports further PFC reductions by the semiconductor industry.<sup>5</sup> Staff recommends that this item be presented to the Board within 18 months.

**Leakage Considerations:** The movement of semiconductor production facilities and older equipment from California to regions beyond California may result in leakage effects. The Semiconductor Industry Association (SIA) has indicated that California semiconductor manufacturing has been in decline over the last decade. The reasons vary from high capital costs, to tax advantages offered by other state and foreign governments, to lower financial risks associated with overseas foundry manufacturing compared to self-manufacture. The illustration provided by SIA is that from 1995 to 2006, three of the six MOU California companies ceased manufacturing operations. The corresponding decline in emissions was that California went from representing nearly 8 percent of U.S. emissions to just 3 percent. Staff needs to determine if the decline in California's emissions represents a shift of PFC emissions to other countries such as China. If so, we will need to determine if those manufacturers are using older equipment sold by California firms which may result in high emissions.

### Affected Entities

#### Industry:

- Semiconductor fabrication industry
- Semiconductor Industry Association

#### Government:

- Local air pollution control districts
- California Energy Commission
- U.S. EPA

**8. Division:** Stationary Source Division  
**Staff Lead:** Dale Trenchel  
**Section Manager:** Terrel Ferreira  
**Branch Chief:** Barbara Fry

## 9. References:

1. *Emission Reduction Opportunities for Non-CO2 Greenhouse Gases in California, Public Interest Energy Research Program: Final Project Report, California Energy Commission, July 2005.*
2. *Memorandum of Understanding between the Semiconductor Industry Association (SIA) and the United States Environmental Protection Agency, January 2001.*
3. *Internal estimate, spreadsheet filename cost.xls, 2007.*
4. *Proposed Early Actions to Mitigate Climate Change in California, Air Resources Board, April 20, 2007.*
5. *Climate Action Team Report to Governor Schwarzenegger and the Legislature, California Environmental Protection Agency, March 2006.*

# Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

## 1. Early Actions Strategy Name and Proponent

SUMMARY #            C03  
ID NUMBER:           ARB 2-5  
TITLE:                FOAM RECOVERY/DESTRUCTION PROGRAM  
PROPONENT:          AIR RESOURCES BOARD STAFF

## 2. Staff Recommendation

This measure was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, no change in the classification of this measure is recommended. The Board date for consideration of this item is anticipated in 4<sup>th</sup> quarter of 2011.

This timing will allow staff the time to complete inventory research<sup>1</sup>, interagency coordination, economic analyses, staff reports, stakeholder workshops, and public hearings to support the necessary regulation(s).

An alternative or complimentary approach may include establishing a voluntary agreement for recovery and destruction for certain foams, if the agreement can be implemented more cost-effectively and can be expected to yield similar CO<sub>2</sub>E benefits as mandatory compliance.

## 3. Early Action Description

This strategy involves a regulatory measure(s) to implement a program to recover and destroy high-GWP insulating foams from buildings, other construction/demolition (C/D) waste, and appliances at end-of-life (EOL). The appliance foam recovery would be coordinated with the US EPA, as they have implemented a similar, voluntary program with some utility providers<sup>2</sup>.

Many foams contain high-GWP GHG blowing agents, especially older insulating foams used in appliances and buildings, that contain chlorofluorocarbon (CFC) blowing agents such as CFC-11 (100-year direct GWP of 4,600).

Currently, foams are either broken (building panels) or shredded (appliances) and landfilled; at this time, no federal or state laws require that foams containing ozone depleting substance (ODS) or other high-GWP blowing agents in the foam be removed and destroyed<sup>3</sup>.

Foam recovery from appliances may either be done manually, or as part of a fully automated recovery system in which appliance refrigerant is removed/de-gassed, the appliance is

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<sup>1</sup> Inventory work in this area is expected to be complete by late 2009.

<sup>2</sup> Responsible Appliance Disposal program, or RAD: <http://www.epa.gov/ozone/snap/emissions/radp.html>

<sup>3</sup> Although refrigerant removal is required at appliance EOL under federal and state law, it is unknown at this time whether foam and refrigerant recovery would be performed by the same people at the same time; the process and technician certification requirements are expected to differ.

shredded, with the refrigerant in the foam collected from the gaseous and solid phases and subsequently destroyed.

#### 4. Potential Emission Reductions

Estimated annual emission reductions of 0.9 MMTCO<sub>2</sub>E are currently possible for residential refrigerator and freezer foam recovery<sup>4</sup>. This number may be offset somewhat by CO<sub>2</sub> emissions associated with foam destruction<sup>5</sup>. Of the 0.9 MMTCO<sub>2</sub>E, 0.8 MMTCO<sub>2</sub>E is due to recovery of foam containing R-11.

The CO<sub>2</sub>E emission reductions are calculated for 2005 with only refrigerators and freezers considered since quantities of insulating foams recovered from A/Cs and building wastes annually in California are unknown. Without knowledge of the numbers and age distributions of appliances in California, 2020 emissions reductions based on sector growth and transitional blowing agent use estimates were not possible. However, it is reasonable to assume that approximately 0.9 MMTCO<sub>2</sub>E reductions will be possible every year until refrigerators and freezers containing R-11 are gone.

To summarize, by about 2012 annual emissions reductions of **0.9 MMTCO<sub>2</sub>E** may be possible by recovering foams banked in old refrigerators and freezers that would otherwise go to landfills. Emissions benefits associated with foam recovery from building and additional C/D wastes could not be estimated.

#### 5. Estimated Costs/Economic Impacts and the Impacted Sectors/Entities

The US EPA estimates that automated foam recovery at appliance EOL costs approximately **\$6.5/TCO<sub>2</sub>E**, while manual foam recovery at appliance EOL costs approximately **\$48/TCO<sub>2</sub>E**. The US EPA states that foam recovery from steel faced building panels is cost effective where large volumes of panels are in one place<sup>6</sup>.

The impacted sectors and entities would mostly be appliance salvagers/recyclers and possibly individuals disposing of foam-containing appliances, as recovery costs are expected to be passed along to the user. Recovery of foam from buildings is not currently performed.

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<sup>4</sup> The following assumptions were used: 1) 20 year lifetimes for refrigerators, 2) R-11 use in refrigerators stopped in 1995; from 1995 – 2005 HCFC-141b was used, 3) in 2005, half of disposed refrigerators contain R-11 as the foam blowing agent and the other half contain 141b, 4) 25% of the foam blowing agent is lost into the cabinet and is released into the atmosphere and that the remaining 75% is recoverable, 5) 13,000,000 refrigerator/freezers are disposed of annually in the US and 60% go to landfills or transfer stations 6) the California population fraction was roughly 13% in 2005, 7) 100-year direct GWPs of 4600 and 700 were used for R-11 and HCFC-141b, respectively, 8) blowing agent masses of 0.45 kg/appliance and 0.38 kg/appliance for R-11 and HCFC-141b, respectively, were obtained from USEPA (Dave Godwin, personal conversation, 2/07).

<sup>5</sup> An additional 0.8 MMT CO<sub>2</sub>E should be avoided at appliance EOL, as refrigerant recovery is mandated by federal and state law; this is discussed in the following strategy, ARB 4-2. Foam destruction would require a large amount of additional analysis; currently, USEPA is developing a plan to destroy ODSs at RCRA facilities, and the operating assumption is that the CO<sub>2</sub> emissions associated with relatively small amounts of foams and refrigerants are small compared to the hazardous waste destruction throughput of a typical RCRA facility, but this supposition is subject to further analysis and change.

<sup>6</sup> USEPA, Draft Proposed Measures Arising from the IPCC/TEAP Special Report & its Supplement, by End-Use, Expert Workshop on IPCC/TEAP Special Report, July 2006.

A foam recovery program for appliances is currently operating as an incentive program between the US EPA and utility companies, some of which are located in California (Responsible Appliance Disposal program, or RAD, see following strategy, ARB 4-2). The program was started in 2006 and the success of the program has not been gauged yet, although it is anticipated that a mandatory program would be more effective.

## 6. Technical Feasibility

The technology required to remove foam blowing agents from appliances and other construction and demolition wastes is feasible, but labor intensive if manual removal is employed. Automated foam removal from appliances is technically feasible, and can be performed during scrap metal processing and recovery.

## 7. Additional Considerations

Ozone depleting substances (ODSs) were used in the past as foam-blowing agents; CFC-11 (100-year direct GWP of 4,600) was used for many years, and phaseout of its replacement, HCFC-141b (100-year direct GWP of 700), from appliance foam has only been occurring in the past four years. Recovering and destroying ODSs may be a cost-effective way to reduce high-GWP gas emissions, and also reduces negative impacts on stratospheric ozone.

It is also possible that special facilities will need to be constructed if automated foam removal is deemed more economically feasible than manual foam removal and would therefore need to be considered in any estimates of cost-effectiveness.

The impacted sectors and entities would mostly be appliance salvagers/recyclers and possibly individuals disposing of foam-containing appliances, as recovery costs are expected to be passed along to the user. California trade associations associated with recycling of scrap metals are unknown. Coordination with the US EPA with respect to this regulation is ongoing.

**8. Division:** Research Division  
**Staff Lead:** Whitney Leeman  
**Section Manager:** Vacant  
**Branch Chief:** Richard Corey

## 9. References

*Arthur D. Little, Inc., Global Comparative Analysis of HFC and Alternative Technologies for Refrigeration, Air Conditioning, Foam, Solvent, Aerosol Propellant, and Fire Protection Applications, Final Report to the Alliance for Responsible Atmospheric Policy, March 21, 2002.*

*David Godwin (USEPA), Marian Martin Van Pelt and Katrin Peterson (ICF Consulting), Modeling Emissions of High Global Warming Potential Gases from Ozone Depleting Substance Substitutes, 2003.*

*IPCC/TEAP, IPCC Special Report on Safeguarding the Ozone Layer and the Global Climate System, Issues related to Hydrofluorocarbons and Perfluorocarbons, 2005.*

*SEPA, Guidance on the Recovery and Disposal of Controlled Substances Contained in Refrigerators and Freezers, 2002: [http://www.sepa.org.uk/pdf/consultation/closed/2003/fridge/fridge\\_consultation.pdf](http://www.sepa.org.uk/pdf/consultation/closed/2003/fridge/fridge_consultation.pdf)*

*USEPA, Draft Proposed Measures Arising from the IPCC/TEAP Special Report & its Supplement, by End-Use, Expert Workshop on IPCC/TEAP Special Report, July 2006.*

USEPA, RAD program website: <http://www.epa.gov/ozone/snap/emissions/radp.html>

# Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

## 1. Early Actions Strategy Name and Proponent

SUMMARY #            *C04*  
ID NUMBER:         *ARB 2-6*  
TITLE:                *GUIDANCE AND PROTOCOLS FOR LOCAL GOVERNMENTS TO FACILITATE GHG EMISSION REDUCTIONS*  
PROPONENT:        *AIR RESOURCES BOARD STAFF*

## 2. Staff Recommendation

This measure was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, no change in the classification of this measure is recommended. The Board date for consideration of this item is anticipated in 3<sup>rd</sup> quarter of 2008.

Local governments have the power to affect the main sources of pollution directly linked to climate change through infrastructure investments, land use decisions, building codes, and municipal service management. While a handful of local governments in California have already started to plan and implement local GHG reduction measures, development of a State guidance document and local government protocols is needed to encourage and support greater and coordinated local action statewide. Furthermore, development of these items will help ensure consistency and coordination between the multiple state agencies involved with implementing AB 32, with regard to supporting and advising Local Government actions for GHG reductions.

Staff recommend developing guidance documents for Local Governments that outline GHG reduction opportunities, as well as protocols for emission reduction accounting.

## 3. Early Action Description

The first step of this strategy will be to coordinate with the Climate Action Team, local governments, the California Climate Action Registry, and local government support organizations like ICLEI (Local Governments for Sustainability). The guidance document will address: 1) best practices for local governments to reduce GHG emissions; 2) categorization and prioritization of strategies by applicability to community types (i.e., urban, suburban, rural), cost-effectiveness, time needed to achieve reductions, etc.; 3) local government protocols for emission reduction accounting; and 4) appropriate modeling tools to support emission quantification at the local level.

Specific recommendations could include: implementing green building standards, stronger recycling programs, energy conservation, changing municipal fleets to cleaner alternatives (gas-electric hybrids, natural gas fueled vehicles, etc.), promoting sustainable communities and smart growth; encouraging LED street and traffic lights; promoting alternative energy (e.g. solar).

These are effective actions that local governments can implement to reduce carbon emissions, which not only help the environment but could be cost effective.

Guidance documents and protocols from this strategy will be voluntary not regulatory and will be developed in close coordination with stakeholders representing state, local, regional and industry perspectives. A strong long-term local level education program will be necessary for successful implementation.

**Groups to work with include:**

**Trade Associations:** California Building Industry Association (CBIA), League of California Cities, California State Association of Counties (CSAC), California Association of Councils of Governments (CALCOG).

**Government Agencies:** Governor's Office of Planning and Research, California Air Pollution Control Officers Association (CAPCOA), and Local Air Pollution Control Districts, local government agencies, Cal/EPA's Climate Action Team and its Land Use/Smart Growth Subgroup, Department of Community and Housing Development, Department of Transportation, California Energy Commission, Integrated Waste Management Board.

#### **4. Potential Emission Reductions**

Potential emission reduction impacts are difficult to predict with current knowledge.

#### **5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities**

Estimated costs and economic impacts are difficult to determine and this time.

#### **6. Technical Feasibility**

With regard to developing a best practices document for Local Government, many other cities, states, and private organizations have acknowledged the need to reduce global warming pollution and have taken steps to coordinate concerted efforts. Below is a list of just a few national and international programs that staff will consider closely:

- U.S. Mayors for Climate Protection - promote actions that city governments can do to profitably and reduce carbon emissions.
- The Clinton Climate Initiative - works with C40 Large Cities Climate Leadership Group, an association of large cities dedicated to tackling climate change—to develop and implement a range of actions that will accelerate greenhouse gas emissions reductions.
- ICLEI's Cities for Climate Protection™ (CCP) Campaign - assists cities to adopt policies and implement quantifiable measures to reduce local greenhouse gas emissions, improve air quality, and enhance urban livability and sustainability. More than 800 local governments participate in the CCP, integrating climate change mitigation into their decision-making processes.

As for protocols for emission reduction accounting, the California Climate Action Registry (CCAR) is currently under contract with the ARB to develop a suite of protocols for reporting and certifying GHG emission reductions for Local Governments. As part of this effort, CCAR will be preparing a scoping document that describes the full scope of local government activities and operations to which quantification protocols can be applied. Data and analysis from this work will support development of a Local Government guidance document.

## **7. Additional Considerations**

Many of the actions that may be recommended fall under the jurisdiction of other state and local agencies therefore this strategy will provide advice and support action, rather than mandate.

An important aspect of this strategy will be verification of the emission reductions and the value associated with it. Future efforts will focus on how local governments can take credit for net reductions and best uses for those credits.

**Proposed Board Hearing Date:** July 2008

**8. Division:** Office of Climate Change  
**Staff Lead:** James Goldstene

# Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

## 1. Early Actions Strategy Name and Proponent

SUMMARY #            C05  
ID NUMBER:           2-7  
TITLE:                GUIDANCE/PROTOCOLS FOR BUSINESSES TO FACILITATE GHG  
                          EMISSION REDUCTIONS  
PROPONENT:         AIR RESOURCES BOARD STAFF

## 2. Staff Recommendation

This measure was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, no change in the classification of this measure is recommended. The Board date for consideration of this item is anticipated in 2<sup>nd</sup> quarter of 2008.

Currently, California businesses' energy consumption contributes approximately 12 MMTCO<sub>2</sub>E GHG emissions per year. Through strategies such as efficient building practices, motor vehicle fleet changes, operational changes, fossil fuel switching, and recycling, local businesses can reduce cost effectively their carbon footprint. These emission reductions range from quite minor to very significant and all reductions will assist the State in meeting its targets under AB32.

Greenhouse gas emission reduction guidance and suggested strategies for local businesses will be presented to the Board in July 2008. At present, it is anticipated that implementation of local business reduction measures will be strongly encouraged, but strictly on a voluntary basis with a dedicated and aggressive educational outreach effort. It is also anticipated that initially, guidance will be broad and, hence applicable to a broad spectrum of businesses. In time, the guidance will evolved into focused, sector-specific recommendations. To the extent possible, a robust emission verification element will be integrated into the guidance so that reductions can be quantified.

## 3. Early Action Description

This strategy will provide guidance and informational resources to local businesses on best practices, emission calculation and verification methods, case studies, cost-effectiveness information, and other tools to assist in reducing greenhouse gas emissions. The guidance will seek to distill and translate the vast amount of information already existing into tangible and concrete steps that local business can implement. Staff's efforts will be focused on reaching out to small/mid-size businesses to engage them in the development of actions, to offer guidance for estimating emissions, identifying and quantifying reductions, and facilitating actions to reduce carbon footprints. Information on relevant options, particularly those that have been implemented successfully by others at a local or national level will be highlighted.

This strategy will focus on businesses ranging from a small office to mid-size corporations and will address the climate benefits of both operational and behavioral changes. Operational changes could include the use of *Energy Star* equipment, compact fluorescent light bulbs, water conservation, recycling, and motor vehicle fleet changes. In addition to physical changes to the

operation of the business (e.g., new construction, retrofits to existing buildings), the guidance will address the benefits of behavioral changes such as incentives for carpooling/walking/bicycling to the workplace, facilitate employees walking to lunch, procuring “green” products, incentives for reducing waste/electricity consumption, Governor’s Awards program to recognize green business leaders, etc. Businesses that choose to pledge to participate in the effort for climate protection will be encouraged and assisted to inventory and report their emissions via recognized channels such as the California Climate Action Registry.

To be successful, this strategy must convince businesses to embrace new projects and initiatives from both environmental and economic perspectives. Thus, a key element of success in the strategy will be to determine how enhancements of operational efficiencies can result in increased profits for a participating business via savings in energy consumption. In addition to working with established organizations that represent or have strong ties with the targeted audience (small and medium business owners/managers), emphasis will be placed on implementation through a variety of means (e.g., information in association newsletters, presentations at trade meeting, web-based tools, etc.). ARB staff will monitor the effectiveness of and response to efforts in order and make necessary adjustments as needed to strengthen the program into the future.

#### **4. Potential Emission Reductions**

Energy efficiency measures associated with green buildings address lighting, heating and cooling, water conservation, refrigeration, and recycling and often lead to a large decrease in GHG emissions. The US Department of Energy states that new energy-efficient design can cut energy usage by 50%; renovation of existing buildings can yield savings of up to 30%. Governor Schwarzenegger signed Executive Order S-20-04 in 2004, which sets a goal of reducing energy use in State-owned buildings 20% by 2015 (from a 2003 baseline). The private commercial sector is encouraged to do the same. The California Energy Commission estimated 2004 GHG emissions in the commercial sector to be approximately 12 MMTCO<sub>2</sub>E. Thus, achieving a 20% reduction in GHG emissions as called for in the Executive Order could potentially realize a reduction of more than 2 MMTCO<sub>2</sub>E in the commercial sector.

#### **5. Estimated Costs / Economic Impacts and the Impacted Sectors/ Entities**

Cost information will vary widely depending on the specific action implemented by a local business. Thus, it is premature to report this information at this time. However, information coming from existing examples that have successfully achieved improvements indicates that the return on investment for energy efficiency measures is often recovered in three to five years, resulting in long term cost savings due to lower utility bills. Measures that could be implemented pursuant to this proposed early action are quite varied and potentially include installation of LED exit signs, efficient refrigeration systems, improved building insulation, purchase of *Energy Star* appliances and office equipment, and implementation of recycling programs. Improvements that are scaleable to square footage of operations will be pursued so that the emission reduction benefits can be pursued across all sizes of businesses.

#### **6. Technical Feasibility**

The proposed strategy benefits from the successful experience from several local businesses and other entities that have already set targets and developed climate action plans. The mitigation strategies will likely be a suite of best practices already in use and proven to be

feasible and effective. Staff will work with the business community to ensure that this strategy focuses on activities and provide information that will promote real, quantifiable, and sustainable reductions. We will also focus on the most effective ways to target the information at decision makers. Hurdles may include developing and implementing guidance that is sufficiently specific and documented.

## **7. Additional Considerations**

ARB will work in consultation with several agencies including: 1) California Energy Commission, 2) Business Associations 3) California Climate Action Registry 4) California Chamber of Commerce, 5) Utility providers, as well as many others.

**8. Division:** Research Division/Planning and Technical Support  
Division/Office of Climate Change  
**Staff Lead:** TBD  
**Section Manager:** Annmarie Mora  
**Branch Chief:** Alberto Ayala

## **9. References:**

*California Energy Commission, Inventory of California Greenhouse Gas Emissions and Sinks: 1990 to 2004, October 2006.*

*U.S. Department of Energy, Energy Efficiency and Renewable Energy, Building Technologies Program, <http://www.eere.energy.gov/buildings/info/office/index.html>, January 27, 2006.*

# Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

## 1. Early Actions Strategy Name and Proponent

SUMMARY #            C06  
ID NUMBER:           ARB 2-8  
TITLE:                REDUCE SULFUR HEXAFLUORIDE (SF<sub>6</sub>) FROM ELECTRICAL  
                          GENERATION  
PROPONENT:         AIR RESOURCES BOARD STAFF

## 2. Staff Recommendation

This measure was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, no change in the classification of this measure is recommended. The Board date for consideration of this item is anticipated in 2<sup>nd</sup> quarter of 2011.

## 3. Early Action Description

This strategy proposes that the ARB develop a measure to reduce sulfur hexafluoride (SF<sub>6</sub>) emissions from the electric power industry, which is the primary user of SF<sub>6</sub>. SF<sub>6</sub> is a synthetic gas used as an insulating medium. The most common use for SF<sub>6</sub> is as an electrical insulator in high-voltage equipment that transmits and distributes electricity. Since the 1950's, the U.S. electric power industry has used SF<sub>6</sub> widely in circuit breakers, gas-insulated substations, and other switchgear used in the transmission system to manage the high voltages carried between generation stations and customer load centers. Fugitive emissions of SF<sub>6</sub> can escape from gas-insulated substations and switchgear through seals. It can also be released during equipment installation and when equipment is opened for servicing. Several factors affect SF<sub>6</sub> emissions from electric power systems, such as the type and age of the equipment (e.g., older circuit breakers can contain up to 2,000 pounds of SF<sub>6</sub>, while modern breakers usually contain less than 100 pounds), and the handling and maintenance procedures practiced by the utilities.

SF<sub>6</sub> is a highly potent greenhouse gas. Over a 100-year period, SF<sub>6</sub> is 23,900 times more effective at trapping infrared radiation than an equivalent amount of carbon dioxide. SF<sub>6</sub> is also a very stable chemical, with an atmospheric lifetime of 3,200 years. Consequently, it will accumulate in the atmosphere.

The U.S. Environmental Protection Agency (U.S. EPA) reports that the most promising and cost-effective options to reduce SF<sub>6</sub> emissions are leak detection and repair, use of recycling equipment, and employee education and training.

## 4. Potential Emission Reductions

U.S. EPA estimates that the SF<sub>6</sub> emissions from electric power systems in the U.S. in 2005 were 4.9 million metric tons of CO<sub>2</sub>-equivalent (MMTCO<sub>2</sub>E). The Cal/EPA Climate Action Team

Report states that hydrofluorocarbons, perfluorocarbons, and SF<sub>6</sub> accounted for about 3.5 percent of gross 2002 greenhouse gas emissions in California (CO<sub>2</sub>-equivalent). USEPA reports that use of recycling equipment can reduce SF<sub>6</sub> emissions by about 10 percent, and leak detection and repair can reduce SF<sub>6</sub> emissions by 20 percent.

Further investigation is required to determine the portion of SF<sub>6</sub> emissions attributed to the California electric power industry and the most appropriate and effective emission reduction equipment and practices. Therefore, ARB staff cannot yet determine the total emission reduction potential of this strategy.

## **5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities**

U.S. EPA reports that cost-effective operational improvements and equipment upgrades can be accomplished at an average cost of \$9.00 per pound. The cost impacts of this strategy specific to the California power sector cannot be determined at this time as further investigation is required. ARB staff assumes that costs will be borne by the power companies and could translate into increased electricity rates for consumers.

## **6. Technical Feasibility**

The most cost-effective SF<sub>6</sub> emission reduction options reported by USEPA focus on maintenance and education, and therefore do not appear to have any associated major technical issues. However, to the extent that repair and replacement activities are used to reduce emissions, scheduling to minimize electrical system disruption could be an issue.

## **7. Additional Considerations**

**8. Division:** Stationary Source Division  
**Staff Lead:** Chris Gallenstein  
**Section Manager:** Mike Waugh  
**Branch Chief:** Mike Tollstrup

## **9. References:**

<sup>1</sup> California Environmental Protection Agency, "Climate Action Team Report to Governor Schwarzenegger and the Legislature," March 2006.

<sup>2</sup> U.S. Environmental Protection Agency, "SF<sub>6</sub> Emission Reduction Partnership for Electric Power Systems," April 17, 2007: <http://www.epa.gov/electricpower-sf6/index.html>

<sup>3</sup> U.S. Environmental Protection Agency, "SF<sub>6</sub> Emission Reduction Partnership for the Magnesium Industry," November 28, 2006: <http://www.epa.gov/highgwp/magnesium-sf6/faq.html>

<sup>4</sup> U.S. Environmental Protection Agency, "U.S. High GWP Gas Emissions 1990-2010: Inventories, Projections, and Opportunities for Reductions," publication #EPA-000-F-97-000, June 2001.

# Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

## 1. Early Actions Strategy Name and Proponent

SUMMARY #            C07  
ID NUMBER:           ARB 2-10  
TITLE:                ALTERNATIVE SUPPRESSANTS IN FIRE PROTECTION SYSTEMS  
PROPONENT:          STAKEHOLDER SUGGESTION

## 2. Staff Recommendation

This measure was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, no change in the classification of this measure is recommended. The Board date for consideration of this item is anticipated in 4<sup>th</sup> quarter of 2011.

Staff recommends developing a proposal for the use of lower GWP substances in fire protection systems to the extent that safe, technically feasible, and cost-effective alternatives are available. These systems, called total flooding systems, are typically used to protect large computer data management areas in commercial buildings, clean room manufacturing facilities, telecommunications equipment, museums and archives. If further evaluation supports the use of this measure as a early action, the proposal will be considered by the Board by December 2011.

One possible approach (for illustrative purposes only): By 2012, require that all new total flooding fire suppressant systems use fire suppressants with a GWP below a specified threshold. The analysis may also explore requiring, providing the options are technologically feasible and cost-effective, that existing total flooding fire suppressant systems enhance inspections of or replace systems using substances with a GWP above a specified threshold, which may or may not be different than the above-mentioned threshold.

## 3. Early Action Description

Use lower global warming potential (GWP) gases in new fire protection systems to the extent that safe, technically feasible, and cost-effective alternatives are available.

## 4. Potential Emission Reductions

### Statewide Emission Inventory<sup>1</sup>

**2005 GHG Emission Inventory:** 0.05 MTCO<sub>2</sub>

**2020 Projected GHG Emissions:** 0.23 MTCO<sub>2</sub>

**Anticipated 2020 Reductions:** <0.1 MMT CO<sub>2</sub>E which assumes 43 percent control

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<sup>1</sup> All emissions estimates based on USEPA Vintaging Model scaled to California based on population assuming only HFC 227 since HFC 23 is only 1%, Halon emission data are not available at this time. Reduction estimates based on technical feasibility from EPA 2006 for new systems. Including reductions from replacement of systems with Halons or HFCs would increase the reduction potential.

Prior to the 1990s, most total flooding fire suppression systems used Halon 1301, however, it is an ozone depleting substance and, based on the Montreal Protocol on Substances that Deplete the Ozone Layer, its production in the US was completely phased out by the mid-1990s. Due to this fact, new systems have moved to Halon replacements, however, with the exception of the US Department of Defense, there has been no concerted effort to remove existing Halon 1301 systems and recycled Halon 1301 is inexpensive and widely available for recharge needs (Wickham 2002). The lifetime of a system ranges from 10 to 35 years.

There are several Halon alternatives being used in fire suppression systems. The US EPA estimates that HFC 227ea covers approximately 16 percent of the total new flooding fire protection systems with HFC 23 (<1%), inert gas (10%) and not-in-kind alternatives (NIK) such as powdered aerosols, water sprinklers and mist systems making up the remainder of the market (74%) (US EPA, 2006). Although these Halon alternatives are not ozone depletors, HFC 227ea and HFC 23 do have significant global warming potentials (GWP) of 2990 for HFC 227ea and 11700 for HFC 23 (IPCC, 1996). In comparison, Halon 1301 has a GWP of 7030, much higher than the common alternative of HFC 227ea (WMO, 2002).

## **5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities**

The US EPA estimates that the least cost alternative would be approximately \$40/tonne CO<sub>2</sub>E (US EPA, 2006) in the US for new systems. The estimate reflects the relative cost of alternative formulations, space costs, and costs associated with installing a new, and sometimes weightier, type of system. The costs may need to be updated and revised to reflect the situation in California. For example labor costs and heating and cooling costs differ from the average for the US. This analysis did not consider costs for replacement systems.

Total flooding systems are used by a wide variety of sectors with uses varying from data processing centers to the oil and gas industry to military weapons systems. Any requirements effecting new systems will be fairly evenly distributed among the sectors. Systems with low expected lifetimes (10-15 years) will be impacted most in the short-term as systems need to be replaced sooner. Any requirements to replace existing systems may have a larger impact on sectors with systems that have long expected lifetimes (35 years). These sectors were expecting the system to last up to 35 years but may have to upgrade the system much sooner.

## **6. Technical Feasibility**

There are a number of low GWP alternatives to Halons and HFCs for use in total flooding fire suppression systems, however, they need to be analyzed for effectiveness, space constraints, safety concerns, and other issues. Not every alternative will work in every situation and technical feasibility will be vary based on space needs, human exposure potential for asphyxiates, and other constraints.

## **7. Additional Considerations**

Some factors that need to be considered as part of the evaluation include whether the alternatives are as effective, do the alternatives have increased toxicity, are there any multi-media environmental impacts and whether the strategy would this apply to only new installations or would existing installations need to be retrofitted? Other questions that need to be considered include what happens to the HFCs and Halons from any systems that are phased out, and will other agencies and insurance companies allow their use? Another fundamental

question concerns whether another agency would be more appropriate to adopt the strategy as well as determining if a voluntary measure be just as effective?

**Affected Entities:** Commercial building owners and property management companies, fire suppressant manufacturers (e.g., 3M, Great Lakes Chemical, Brownell, Dupont, Stat-X) and system manufacturers/suppliers (Sea fire, Nautical, Many suppliers – CA based include CalProtection, Chemetron, Diversified Protection, Facilities Protection Inc., Intelligent Technologies and Systems, and RFI Communications & Security).

**Trade Associations:** Building Industry Association, Chemical Manufacturers Association, Building Insurance, Fire Suppression Systems Association, Fire Equipment Manufacturers Association and others.

**Government Agencies to coordinate with:** California Department of Fire Protection, State Fire Marshall's Office, Department of General Services, OEHHA, DHS, Cal-OSHA, and others.

**Proposed Board Hearing Date:** December 2011

**8. Division:** Research Division  
**Staff Lead:** Elizabeth Scheehle  
**Section Manager:** Mike FitzGibbon  
**Branch Chief:** TBD  
**Staff Attorney:** TBD

## 9. References:

*Intergovernmental Panel on Climate Change (IPCC). 1996. Climate Change 1995: The Science of Climate Change. J.T. Houghton, L.G. Miera Filho, B.A. Callander, N. Harris, A. Katterberg, and K. Maskell (eds.). Cambridge, UK: Cambridge University Press.*

*USEPA, 2006. Global Mitigation of Non-CO<sub>2</sub> Greenhouse Gases, EPA Report 430-R-06-005. Available at: <http://www.epa.gov/nonco2/econinv/downloads/GlobalMitigationFullReport.pdf>*

*Wickham, Robert. 2002. Status of Industry Efforts to Replace Halon Fire Extinguishing Agents. Wickham and Associates. March 16. Available at: <http://www.epa.gov/ozone/snap/fire/status.pdf>.*

*World Meteorological Association (WMO). 2002. Scientific Assessment of Ozone Depletion: 2002. Global Ozone Research and Monitoring Project - Report No. 47, 498pp., Geneva, 2003.*

# Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

## 1. Early Actions Strategy Name and Proponent

SUMMARY #            C08  
ID NUMBER:           ARB 2-11  
TITLE:                FORESTRY PROTOCOL ENDORSEMENT  
PROPONENT:          STAKEHOLDER SUGGESTION

## 2. Staff Recommendation

This measure was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, no change in the classification of this measure is recommended. The Board date for consideration of this item is anticipated in the 4<sup>th</sup> quarter of 2007.

Staff recommends this strategy remain on the list as an early action by Board endorsement of the California Climate Action Registry (CCAR) forestry protocols for immediate use to enhance voluntary greenhouse gas emissions reductions. Staff recommends a two-phase process that allows early action by bringing existing sector, project, and certification protocols, developed by CCAR, to the Board for approval in October 2007 and also allows for longer term consideration and review of additional forestry protocol development as determined in the initial public workshop process. Endorsement of sector and project forest protocols would be non-regulatory, because their use would be voluntary.

## 3. Early Action Description

Forestry is the only sector that *actively removes* greenhouse gases from the atmosphere. The CCAR forestry protocols represent the work of leading experts in the field of forestry and in protocol development, the input of stakeholders and the public over a 4-year public process, and the review by 50 external experts, representing the forest industry, policy and academia. The protocols have been approved by the Board of Forestry (2004) and the CCAR Board (2005). The three protocols together – the sector, project, and certification protocols – are a cohesive and comprehensive set of methodologies for forest carbon accounting, and contain the elements necessary to generate high quality, conservative carbon credits. The first step to effective carbon reduction is accurate carbon accounting.

Unlike other sectors, immediate action in the forest sector does not result in instantaneous greenhouse gas reduction, because forests need time to grow to realize reduction benefits. Therefore, the sooner these voluntary protocols are endorsed, the faster forest projects can be put in place, to establish *future* reductions. The three carbon reduction project types – reforestation, conservation forest management, and avoided development – provide an accounting framework for maximizing carbon sequestration and minimizing carbon loss without compromising the other ecosystem functions forest provide (habitat, structure, nutrient cycling), as well as the suite of other benefits humans depend on from the forests (water storage, soil stability, temperature modification, air and water purification, wood products, recreation). As such, they are ready for use in voluntary measures to reduce carbon emissions in California.

#### **4. Potential Emission Reductions**

Because they are critical to accurate carbon accounting, the forestry protocols are required in several of the forest-related Climate Action Team (CAT) strategy implementation plans. A third of carbon reductions through the forest CAT plan depend on application of these forest protocols which equates to a cumulative sequestration of roughly 10 MMTCO<sub>2</sub>eq between now and 2020. The CAT-strategy reforestation projects in the year 2020 are expected to result in GHG emissions reduction of 2 MMTCO<sub>2</sub>eq (CAT, 2007). While there is already interest in the protocols from the private forest sector, the potential emissions reduction from the voluntary use of the protocols could vary depending on a variety of factors, including management activity, site fertility, and available funding. One unpublished industry study suggests a potential increase of 2¼-fold in the pine zone (Steve Brink, California Forestry Association, pers. comm.). Nationally, an additional 100 to 200 Tg C/yr of forest carbon sequestration is achievable, but would require investment in inventory and monitoring, development of technology and practices, and assistance for land managers (Birdsey et al. 2006).

#### **5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities**

Currently, the methodologies for carbon stock assessment require intensive sampling programs to meet the required confidence levels for verification. This is labor and time intensive, and therefore costly. There is currently no better technology/methodology to measure carbon if a high degree of certainty is required in carbon stock assessment. Carbon stock certainty should meet the criteria of other carbon emission estimates in the state (20% of the mean estimate). Smaller landowners may find the cost to implement the sampling and subsequent verification too burdensome to participate. The larger industrial landowners (>30,000 acres) should be able to use forest stocking data from sustained-yield management plans which they are required to submit to California Department of Fire and Forest Protection (CalFire). Data for inventorying large land areas may be accessible from CalFire plot data and USFS Forest Inventory and Analysis plot data.

#### **6. Technical Feasibility**

The carbon accounting techniques used in the forest protocols are standard forest measurement techniques.

#### **7. Additional Considerations**

The forestry protocols are designed for small to mid-sized private forest ownerships. There is a need for continued development of forest accounting methodologies to address outstanding issues for: 1) public forest ownerships and for 2) industrial forest private land ownerships. These issues can be addressed within the framework of the existing protocols by defining additional project types beyond the three project types (reforestation, conservation forest management, and avoided deforestation) in the current protocols. For public landowners, issues to resolve include legality of permanent easement transfer, baseline/additionality definition, and carbon offset ownership. By recognizing the need for additional project types in the future, the existing forestry protocols can be moved forward through the public process, endorsed and implementation immediately while the new project types are developed through a longer term public process. This will expedite the availability of the forest protocols for immediate use, while still allowing due consideration to the different needs of the industrial and public forest sector.

**Affected Entities:** Any forest ownership in California could participate in all forest project types, including state and federal public forests, and private forests. Many non-forest entities might participate in reforestation activities, including local governments, utilities, others.

**Trade Associations:** California Forestry Association.

**Government Agencies Coordination:** California Department of Forest and Fire Protection, Board of Forestry, United States Forest Service.

**8. Division:** Planning and Technical Support Division  
**Staff Lead:** Jeanne Panek  
**Section Manager:** Dale Shimp  
**Branch Chief:** Richard Bode

## 9. References:

*The protocols can be found in their entirety on the California Climate Action Registry website at:*  
<http://www.climateregistry.org/PROTOCOLS/FP/>

*Birdsey, R., K. Pregitzer, and A. Lucier. 2007. Forest Carbon Management in the United States: 1600–2100. J. Environ. Qual. 35:1461–1469.*

*CAT, Climate Action Team. 2007. Climate Action Team proposed early actions to mitigate climate change in California. Draft for public review. April 2007.*  
[www.climatechange.ca.gov/climate\\_action\\_team/reports/2007-04-20\\_CAT\\_REPORT.PDF](http://www.climatechange.ca.gov/climate_action_team/reports/2007-04-20_CAT_REPORT.PDF)

# Staff Analysis of Proposed Early Action for Climate Change Mitigation in California

## 1. Early Actions Strategy Name and Proponent

SUMMARY #            C09  
ID NUMBER:         ARB 2-18 / EJAC-2  
TITLE:                ENFORCEMENT OF FEDERAL BAN ON HFC RELEASE DURING  
                          SERVICE/DISMANTLING OF MVACS  
PROPONENT:         2006 CAT REPORT

## 2. Staff Recommendation

This measure was approved by the Board as an early action at its June 2007 hearing. Based on further evaluation by staff, no change in the classification of this measure is recommended. The Board date for consideration of this item is anticipated in 2<sup>nd</sup> quarter of 2010.

This non-regulatory strategy is expected to be developed in close collaboration with the United States Environmental Protection Agency (US EPA). The strategy is not a stand-alone measure. Rather, it is designed to be implemented in concert with a number of other strategies that staff has identified for mitigating the climate impact of HFCs.

## 3. Early Action Description

The goal of this non-regulatory strategy is improved compliance with a regulation of US EPA (40 CFR 82.154) that prohibits the venting of certain types of refrigerant, including HFCs, to the atmosphere when MVACS equipment is serviced or dismantled. Venting is avoided by recovering refrigerants with specialized equipment. The recovered refrigerant can be re-used by the owner or transferred to re-processors approved by US EPA.

The main focus of the proposed strategy would be the climate impact abatement of HFCs used in the air-conditioning (A/C) systems of vehicles that are to be dismantled. The current degree of compliance with 40 CFR 82.154 is poorly documented but under review. Per this strategy, better compliance by dismantlers would be obtained via a cooperative program that would be created among ARB's Enforcement Division, appropriate offices in the US EPA, and the environmental protection offices of the counties where dismantling activity is taking place. The specific form of the program has not been determined yet, pending quantification of the avoidable emissions of HFCs. However, the anticipated approach would emphasize enhanced enforcement of existing federal requirements for recovery via audits of activities and documentation.

## 4. Potential Emission Reductions

Potential emission reductions from dismantling have been estimated to be in the range of 0.1 to 0.6 MMTCO<sub>2</sub>E in 2010 and 0.1 MMTCO<sub>2</sub>E in 2020. The potential reductions are lower in the year 2020 because it is assumed that half of the cars going to the dismantlers will have new low-GWP refrigerant in the A/C system instead of HFC-134a as called for in other companion

HFC reduction strategies. Preliminary estimates suggest that the refrigerant bank in EOL vehicles could be as high as 0.5 MMTCO<sub>2</sub>E per year. Estimates of annual A/C servicing emissions ranges from 0.3 to 0.6 MMTCO<sub>2</sub>E. The ARB staff has initiated extramural research to estimate the annual amount of HFC that is available for recovery from vehicle at end-of-life and we will continue to work with the USEPA to develop improved estimates of the portion of the available amount that is being recovered and other parameters.

## **5. Estimated Costs / Economic Impacts and the Impacted Sectors / Entities**

Some dismantlers may not have the latest compliant hardware for recovering refrigerants or any equipment at all. Each such dismantler who would be prompted to purchase the equipment would have to spend in the neighborhood of \$3000 to \$4000 per unit. The number of units needed would depend on the size of the operation (vehicle throughput). However, this would be an expense that the dismantler has so far avoided only through failure to comply with the existing federal regulation. Thus, this is not a cost burden associated with the proposed strategy.

The same statements apply to obtaining certification for technicians who use the recovery equipment, but with minimal anticipated costs. Training for the US EPA's certification program is offered by various commercial schools. In addition, the Mobile Air Conditioning Society offers free training (a downloadable pamphlet) and a nominal exam fee, so the necessary expense for operator certification should be minimal.

## **6. Technical Feasibility**

This measure is technically feasible because it is the current federal law, which has been in existence for some time. As such, the equipment exists to recover the refrigerant from automobile A/C systems whether they are being serviced or dismantled. The rigorous enforcement of the federal regulation in California is meant to force vehicle dismantlers to universally use refrigerant-recovery equipment as required by law. The same is true for garages and auto service centers that service MVACS; however, the fraction of such shops that do not have the requisite equipment may be small. It should be noted that recovery procedures and equipment are being revised by industry standard setting bodies to make the process more effective with a higher recovery rates of the refrigerant.

## **7. Additional Considerations**

This strategy involves the enforcement of an existing federal regulation (U.S. EPA- 40 CFR 82.154) that prohibits the venting of refrigerants to the atmosphere when the MVACS is being serviced or dismantled. Some local air districts adopt the federal regulation by reference and others have their own regulation which prohibits the release of refrigerants into the atmosphere. Originally, this item was a strategy in the Climate Action Team Report of March 2006 that ARB intends to pursue as one of suite of measures designed for reducing HFC refrigerant impacts. This strategy involves the creation of a cooperative program among ARB's Enforcement Division, appropriate offices in the U.S. EPA, and local air districts in California. U.S. EPA is currently working on a regulatory impacts assessment that will estimate the emission reductions and costs associated with this type of measure. That work and other on-going activities are expected to yield the necessary additional information for strategy development such as the number of non-compliant dismantlers and shops that perform MVACS servicing in California.

**8. Division:** Research Division  
**Staff Lead:** Winston Potts  
**Section Manager:** Tao Huai  
**Branch Chief:** Alberto Ayala

**9. References:**

<sup>1</sup>Vincent, R., "HFC Reduction Strategy 2-2-5, Enforcement of the Federal Ban on Releasing HFCs During Servicing and Dismantling of MVACS," California Air Resources Board, 2006. As presented in the Climate Action Team Report of March 2006.

<sup>2</sup>Air Resources Board, HFC-134a as an Automotive Refrigerant - Background, Emissions and Effects of Potential Controls, August 6, 2004 ([www.arb.ca.gov/cc/cc.htm](http://www.arb.ca.gov/cc/cc.htm))

<sup>3</sup> Karen Thundiyil, USEPA, personal communication, 7/26/07.

<sup>4</sup> Improved Mobile Air Conditioning Program (IMAC), "Reducing Refrigerant Emissions at Service and Vehicle End of Life," June 30, 2007