Revised Cost Analysis for Regulatory Changes to the Listing Status of High-GWP Alternatives

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Executive Summary

This analysis presents an estimate of the overall potential costs associated with a rulemaking to change the listing status of certain high-GWP alternatives used in aerosols, foams, commercial refrigeration, and motor vehicle air conditioning (MVAC). Exhibit 1 summarizes the regulatory changes analyzed. While about 645,000 businesses are potentially affected by this rule, the analysis estimates that the rule is expected to result in changes in costs for less than 0.1% of those businesses. Using a 7% discount rate, total annualized compliance costs across affected businesses are estimated to range from $28.0 million to $50.6 million; total annual savings are estimated to be about $19.3 million; thus total annualized upfront compliance costs and annual savings combined are estimated to range from $8.7 million to $42.7 million. Using a 3% discount rate, total annualized compliance costs across affected businesses are estimated to range from $19.5 million to $37.8 million, total annual savings are estimated be about $19.3 million, and thus total annualized upfront compliance costs and annual savings combined are estimated to range from $0.2 million to $31.9 million.

Exhibit 1: Summary of Regulatory Changes Analyzed

- List unacceptable HFC-134a for new MVACs starting in model year 2021; narrowed use limits apply for export to countries without servicing infrastructure through MY 2025
- List unacceptable HFC-125 for aerosols in 2016, restrict use of HFC-134a to certain medical aerosols and technical aerosols in 2018 and one year from date of publication; restrict use of HFC-227ea and blends to metered dose inhalers in aerosols one year from date of publication.
- List unacceptable certain HFCs and HFC blends in 1) rigid polyurethane appliance foam; 2) flexible polyurethane; 3) rigid polyurethane: commercial refrigeration and sandwich; 4) rigid polyurethane and polyisocyanurate laminated boardstock; 5) rigid polyurethane slabstock; 6) polyurethane integral skin; 7) polystyrene: extruded sheet; 8) polystyrene: extruded boardstock and billet; 9) polyolefin; 10) PU marine flotation foam and 11) phenolic foams in various years from 2017 to 2021 for specified end-uses, except for certain military, space- and aeronautics- related applications.

Commercial Refrigeration:

- List unacceptable 10 high-GWP HFCs/HFC blends for: new supermarket systems in 2017; new remote condensing units in 2018.
- List unacceptable 9 high-GWP HFC blends for: retrofitted supermarket systems and retrofitted remote condensing units one year from date of publication.
- List unacceptable 31 high-GWP HFCs/HFC blends for: new stand-alone medium-temperature units with a compressor capacity below 2,200 Btu/hr and not containing a flooded evaporator in 2019 and all other new stand-alone medium-temperature units in 2020.
- List unacceptable 24 high-GWP HFCs/HFC blends for new stand-alone low-temperature units in 2020.
- List unacceptable 20 high-GWP HFCs/HFC blends for new vending machines in 2019.
- List unacceptable R-404A and R-507A for: retrofitted vending machines and retrofitted stand-alone retail food refrigeration equipment one year from date of publication.

Methodology

This analysis builds on the general approach taken previously to estimate potential economic impacts on small businesses—as described in *Economic Impact Screening Analysis for Regulatory Changes to the Listing Status of High-GWP Alternatives*—to extend the assessment to all-sized businesses potentially affected by the rulemaking. Industries potentially affected by these regulatory changes were primarily identified by North American Industry Classification System (NAICS) codes.[1] Costs to affected businesses were calculated using a direct compliance cost method and then annualized. Costs or savings associated with changes in energy efficiency were not estimated because energy efficiency is related to a number of factors, including equipment design or thickness of foam, and not just to the refrigerant or foam blowing agent used.

Apart from a few exceptions, this analysis uses the same assumptions as the small business screening analysis, including those about:

[1] The small business threshold varied for specific industries based on their NAICS code.

- Which industries might be affected by the regulatory changes;
- The proportion of businesses that could be directly affected by the rulemaking, based on whether the hydrofluorocarbons (HFCs) affected by this rulemaking are still—or were ever—known to be in use, and what proportion of the market the affected HFCs are expected to represent at the time that the status of the HFC changes for that sector;
- The alternatives that are implemented in the transition away from the HFCs affected by this rulemaking, for modeling purposes;[2] and
- The capital, operating, maintenance, and other direct compliance costs incurred by affected businesses.
- The regulation does not prescribe that any business transition to a particular, lower-global warming potential (GWP) refrigerant or alternative technology, so additional costs businesses incur by choosing a different refrigerant/technology are not estimated in this analysis.

This analysis has been updated after reviewing public comments and available information received during the public comment period (See Docket ID No. EPA–HQ–OAR–2014–0198).

Table 1 provides the basic financial assumptions used in this analysis.

Table 1: Financial Assumptions used in Cost Analysis

Parameter	Assumption
Discount rates	3% and 7%
Constant Year Dollars	2013$
Lifetime for annualizing costs	Varies based on equipment type: 25 years for foam manufacturing; 20 years for commercial refrigeration; 10 years for aerosol product manufacturing; Not Applicable for MVACs because costs are estimated per vehicle at time of manufacture

The sections below briefly describe the cost assumptions, as well as additional assumptions that were required for the aerosols and foams sectors to extend the small business economic impact screening assessment to those businesses not characterized as small under the Small Business Administration guidelines (hereafter referred to as “larger” businesses).

Motor Vehicle Air Conditioning Assumptions

The EPA has previously examined when automobile manufacturers may be able to transition their fleets to lower-GWP refrigerants in its rules to extend the greenhouse gas and fuel economy standards for model year

[2] The transition scenario analyzed here reflects possible steps towards compliance with the final rule. The transition scenario reflects a direct compliance cost method and does not assume the regulated community chooses higher-cost solutions where known solutions exist. A separate technical support document analyzes the benefits of the final rule and makes separate assumptions on the possible transitions for compliance based on considerations of the market and activity towards lower-GWP solutions. Higher or lower benefits do not necessarily correlate to higher or lower costs due to the different assumptions and methodologies used in the different analyses. However, the transition scenarios assumed here are similar to the lower, less aggressive transition scenario in the benefits analysis.

(MY) 2017–2025 light-duty vehicles. 77 FR 62,624, 62,807-810 (October 15, 2012); see also 75 FR 25,325, 25,431-32 (May 7, 2010) (discussing the same issue for MY 2012–2016 light duty vehicles).

When refrigerants leak from current motor vehicle air conditioning systems, they contribute to overall greenhouse gas (GHG) emissions. Using lower-GWP refrigerants can significantly reduce the climate impact of these emissions. Given the increasing availability of lower-GWP chemicals suitable for this purpose and systems that can use them, as well as increasing requirement for lower-GWP refrigerants in Europe, EPA based the light-duty greenhouse gas (LD GHG) standards for MYs 2017–2025 in part on an expected gradual transition to lower-GWP refrigerants. Thus, in setting the level of the standards, EPA projected that the industry will make the full transition to lower-GWP refrigerants over the period of time spanning between MY 2017 and MY 2021, and the level of the standard in each of these model years reflects a projected 20 percent increase in substitution in each model year and complete transition by MY 2021. 77 FR 62,720/2-3. In support of the assumption of this multi-year transition, the LD GHG rule for MYs 2017–2025 includes an extensive discussion of the refrigerant substitute availability and technical feasibility of transitioning the fleet. 77 FR 62,720; 62,807-810.

Given current industry trends and other regulatory incentives and requirements, all light-duty vehicle and truck manufacturers are expected to transition their vehicle production for domestic sales out of HFC-134a prior to the status change date for this sector (i.e., model year 2021). Factors affecting the transition to lower-GWP refrigerants in MVAC are discussed in the preamble to the final rule as well as in the LD GHG rule and its supporting documents. Because the analysis supporting the LD GHG rulemaking[3] accounted for impacts of a full transition by MY 2021 for domestic sales, this analysis considers only export vehicles to estimate costs that would be incurred as a result of this rulemaking.

Light duty vehicle manufacturers purchase MVAC system components from a third party and then assemble and install the MVAC systems in-house. Potential costs to manufacturers were estimated based on per-system costs of alternative systems, as identified in EPA's report on *Global Mitigation of Non-CO_2 Greenhouse Gases: 2010–2030* (EPA 2013), and converted to 2013 dollars. The incremental per-system cost of an alternative MVAC system compared to an HFC-134a system is estimated to be about $62/unit[4]. These incremental costs are less than 1% relative to the total direct manufacturing cost for a light duty vehicle. It is assumed that the impact of the rulemaking on most export sales is minimal due to export countries with similar regulations or initiatives mitigating HFC-134a use such as the European MAC Directive (2006/40/EC) (European Union 2006). For export countries lacking infrastructure to service low-GWP refrigerants, the rule allows continued use subject to the requirements of a "narrowed use limit" through 2025. In addition, an MVAC could be shipped dry or with a nitrogen holding charge and subsequently charged after leaving the United States. This analysis assumes that low-GWP service infrastructure will be established by 2025 in these export countries and that there will be no incremental costs for vehicle manufacturers to manufacture and export vehicles with lower-GWP refrigerant

[3] Environmental Protection Agency 2012. Regulatory Impact Analysis: Final Rulemaking for 2017-2025 Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards. August 2012. Available online at: http://www.epa.gov/otaq/climate/documents/420r12016.pdf. Accessed October 21, 2013.

[4] Other information received during the public comment period indicated costs could be higher or lower than $62. However, for the purpose of this analysis, costs were estimated as $62/unit to reflect an average of higher and potential lower costs which are expected to be reduced further due to efficiencies of scale.

MVAC systems by 2025.[5] However, for the purpose of this analysis, at the higher end of the range, incremental costs are assumed for manufacturers that may produce solely for an export market for countries that do not have regulations or initiatives mitigating 134a use in motor vehicles or for countries where the market demand is more elastic to incremental cost changes.

Aerosol Assumptions

A significant portion of the aerosol product manufacturing industry never used HFCs; already transitioned out of the HFCs included in the rule; or manufactures products for which the included HFCs will be listed as acceptable, subject to use conditions. However, some tire inflator manufacturers and manufacturers of products for the functional and sensitivity testing of smoke detectors still use HFC-134a propellant and are expected to be affected by this rulemaking. Other uses affected by this rulemaking such as pesticides were not included in this costs analysis because it is difficult to determine costs based on factors outside the control of the aerosol formulator that must be addressed before transitioning such as those that must undergo specific federal governmental reviews.

- **Tire inflator manufacturers**—In addition to the two small businesses identified in the small business screening analysis, two additional manufacturers were identified as potentially still producing aerosol tire inflators containing HFC-134a propellant, using the U.S. Department of Health and Human Services Household Products Database and employee data available from Dun and Bradstreet (2014). In light of public comments indicating that the total production volume and conversion costs were not high enough, this analysis assumes these four manufacturers produce a total of approximately 20.6 million tire inflators per year; this estimate was based on a production estimate from one manufacturer and by applying a ratio of annual sales to that production estimate to approximate annual production for the other manufacturers. The manufacturers are expected to incur one-time capital conversion costs between $342,000 and $1.3 million to convert to hydrocarbons, and annual savings of approximately $0.26 per aerosol can produced due to the lower cost of hydrocarbon-based propellant (EPA 2013). The previous analysis assumed 18.6 million tire inflators per year with a one-time capital cost of conversion of $342,000 per facility to convert to hydrocarbons and annual savings of approximately $0.26 per aerosol can produced due to the lower cost of hydrocarbon-based propellant (ICF 2014b).

- **Manufacturers of products for the functional testing of smoke detectors**—In light of public comments, additional analysis was performed specifically on manufacturers of products for the functional testing of smoke detectors. Three small businesses were identified in the small business screening analysis and one additional manufacturer was identified as still producing products containing HFC-134a propellant, using available employee data and parent company information. Although production totals for these smoke detector tester products are not available, the market is considered to be very small. The

[5] Light duty vehicle manufacturers purchase MVAC system components from a third party and then assemble and install the MVAC systems in-house. Currently, potential costs to manufacturers are estimated based on per-system costs of alternative systems, as identified in EPA's report on *Global Mitigation of Non-CO_2 Greenhouse Gases: 2010-2030* (EPA 2013), and converted to 2013 dollars. The incremental per-system cost of an alternative MVAC system compared to an HFC-134a system is estimated to be about $62/unit. These incremental costs are less than 1% relative to the total direct manufacturing cost for a light duty vehicle.

affected manufacturers are expected to incur one-time capital conversion costs between $105,000 and $530,000 to convert to HFO-1234ze propellant, and annual costs of approximately $0.13 per aerosol can produced due to the higher cost of HFO-1234ze propellant (EPA 2013). The previous analysis for the proposed rulemaking did not include an estimate on manufacturers of products for the functional testing of smoke detectors (ICF 2014b).

Foams Assumptions

The rulemaking is not anticipated to affect manufacturers in some foam types (polystyrene extruded sheet, flexible polyurethane: slabstock and moulded, rigid polyurethane, polyolefin, phenolic) because these foam types are not known to be currently manufactured in the United States using the HFCs listed as unacceptable. The regulatory changes would serve to avoid the future use of these HFCs in these foam types.

In the foams sector, compliance costs generally include one-time capital costs for a production facility to transition to an alternative blowing agent; in some foam end-uses, these capital costs would be offset by annual savings associated with lower alternative blowing agent costs. Assumptions are briefly described below; for more detail, please see *Economic Impact Screening Analysis for Regulatory Changes to the Listing Status of High-GWP Alternatives*.

Polystyrene Foam Product Manufacturing:

- **Polystyrene: Extruded Boardstock and Billet**—All known XPS manufacturers are larger businesses (i.e., having more than 499 employees[6]). Companies still using HFC-134a are assumed to transition to hydrocarbons. In light of public comments indicating that the conversion costs were not high enough, this analysis assumes capital costs for a facility to transition to hydrocarbons to be approximately between $4.6 million and $7.2 million per production line. Each large business is assumed to have three production lines (UNEP 2011b, 2013b). The previous analysis assumed capital conversion costs of $641,000 per production line (ICF 2014).

Household Refrigerator and Home Freezer Manufacturing:

- **Rigid Polyurethane: (Household) Appliance**— Companies still using HFC-245fa and HFC-134a are assumed to transition to either hydrocarbons or Solstice LBA. Hydrocarbons may be a more cost-effective option over the equipment's lifetime, but Solstice LBA is assumed to be adopted by small businesses to help achieve energy efficiency standards and/or to avoid incurring upfront capital costs. Specifically, the smallest businesses (i.e., establishments with zero to nine employees) are assumed to transition fully to Solstice LBA, while other small businesses (i.e., establishments with more than 10 to 999 employees are assumed to transition 50% to Solstice LBA and 50% to hydrocarbons. Larger businesses (i.e., establishments with more than 999 employees[7]) were assumed to transition fully to hydrocarbons. In light of public comments indicating that the conversion costs were not high enough, this analysis assumes capital facility costs to convert to hydrocarbons to be between $5.1 million and $6.1 million per facility (EPA 2013), but these costs are offset by annual savings of up to $4.8 million per facility due to lower blowing agent costs; savings vary depending on facility size (i.e., number of units

[6] The small business threshold varied for specific industries based on their NAICS code.
[7] *Idem.*

produced). The previous analysis assumed capital conversion costs of $5.1 million per facility to convert to hydrocarbons (ICF 2014). No capital costs were assumed to convert to Solstice LBA (since this option is considered to be a near drop-in replacement for HFC-245fa), but annual costs per facility were estimated to be between $2,000 and $3.0 million per facility,[8] due to higher blowing agent costs; annual costs vary depending on facility size (i.e., number of units produced). This analysis assumes a higher and lower estimate In light of public comments received on annual costs per facility. The previous analysis assumed annual costs per facility of $2.5 million per facility to convert to Solstice LBA (ICF 2014).

Commercial and Industrial Refrigeration Equipment Manufacturing:

- **Rigid Polyurethane: Commercial Refrigeration—** Companies still using HFC-245fa and HFC-134a are assumed to transition to either hydrocarbons or Solstice LBA. Hydrocarbons may be a more cost-effective option over the equipment's lifetime, but Solstice LBA is conservatively assumed to be adopted by small businesses to help achieve energy efficiency standards and/or to avoid incurring upfront capital costs. Specifically, the smallest businesses (i.e., establishments with zero to nine employees) are assumed to transition fully to Solstice LBA, while other small businesses (i.e., establishments with 10 to 749 employees are assumed to transition 50% to Solstice LBA and 50% to hydrocarbons. Larger businesses (i.e., establishments with more than 749 employees[9]) are assumed to transition fully to hydrocarbons. In light of public comments indicating that the net annual savings were too high, this analysis assumes capital costs to transition to hydrocarbons are assumed to total approximately $1.3 million per facility, while net annual savings are estimated to be between $1.3 million and $1.6 million per facility, due to lower blowing agent costs; savings vary depending on facility size (i.e., number of units produced). The previous analysis assumed net annual savings of $2.8 million per facility to convert to hydrocarbons (ICF 2014). No capital costs are assumed to convert to Solstice LBA (since this option is considered to be a near drop-in replacement for HFC-245fa), but annual costs per facility are estimated to be between $500 and $754,000 per facility,[10] due to higher blowing agent costs; annual costs vary depending on facility size (i.e., number of units produced) (EPA 2013). This analysis assumes a higher and lower estimate In light of public comments received on annual costs per facility. The previous analysis for the proposed rulemaking estimated annual costs per facility of up to $630,000 per facility to convert to Solstice LBA (ICF 2014).

Urethane and Other Foam Product (Except Polystyrene) Manufacturing:

- **Rigid Polyurethane: Sandwich—** Companies still using HFC-134a are assumed to transition to hydrocarbons. Small businesses are assumed to produce foams containing approximately 13.3 MT of blowing agent annually, and in light of public comments indicating that the conversion costs were not high enough, this analysis assumes businesses incur one-time capital costs for conversion between $183,000 and $220,000 (UNEP 2012, UNEP 2013a), offset partially by anticipated annual savings due to lower blowing agent costs (EPA 2013). The previous analysis assumed conversion costs of $183,000 per

[8] Depending on the number of appliances assumed to be manufactured per facility and the cost of Solstice LBA (which was assumed to range from $14 to $17 per kilogram).

[9] The small business threshold varied for specific industries based on their NAICS code.

[10] Depending on the number of appliances assumed to be manufactured per facility and the cost of Solstice LBA (which was assumed to range from $14 to $17 per kilogram).

facility (ICF 2014). Larger businesses (i.e., establishments with more than 499 employees[11]) are assumed to have a higher production volume, using 450 MT of blowing agent annually, and in light of public comments indicating that the conversion costs were not high enough, this analysis assumes businesses incur one-time capital conversion costs between $336,000 and $403,000, offset by anticipated annual savings of $470,000 due to lower blowing agent costs (EPA 2013). The previous analysis assumed conversion costs of $336,000 per facility (ICF 2014).

- **Rigid Polyurethane: Marine Flotation Foam**— In light of public comments, additional analysis was performed specifically on marine flotation foam. The previous analysis for the proposed rulemaking did not include a separate estimate on marine flotation foam (ICF 2014). In this analysis, it was assumed that companies still using HFC-134a would transition to hydrocarbons (i.e., pentane) and HFO/water blends. The smaller marine flotation foam manufacturers (i.e., those with less than 10 employees) are expected to transition to HFO/water systems. Of the remaining entities, 50% would be expected to transition to pentane blowing agents and the remaining 50% to HFO/water systems.

  Capital costs for transitioning to HFO/water systems were assumed to be between $210,000 and $253,000 per facility, covering the cost of formulation development and compliance testing. Incremental annual operating costs were conservatively estimated to be between $97,000 and $116,000 per facility, due to higher blowing agent costs (EPA 2013).[12]

  Capital costs for transitioning to pentane blowing agents were assumed to be between $210,000 and $632,000 per facility (UNEP 2010c). Incremental annual operating costs were assumed to be zero; while an increase in operating costs may be experienced associated with the use of hydrocarbons—due to the need for raw materials for fire retardants—these costs are not expected to outweigh the annual savings associated with the lower blowing agent cost.

- **Rigid Polyurethane and Polyisocyanurate Laminated Boardstock**— Companies using HFC-134a or HFC-245fa are assumed to transition to hydrocarbons. Small businesses are assumed to produce foams containing approximately 25 MT of blowing agent annually, and in light of public comments indicating that the conversion costs were not high enough, this analysis assumes businesses incur one-time capital costs for conversion between $432,000 and $520,000 (UNEP 2009, 2010, 2011a). The previous analysis assumed conversion costs of $432,000 per facility (ICF 2014). Larger businesses (i.e., establishments with more than 499 employees[13]) are assumed to have a higher production volume, using 65 MT of blowing agent annually, and incur a one-time capital conversion cost between approximately $518,000 and $959,000 (UNEP 2009, 2010, 2011a). This analysis assumes a higher and lower estimate In light of public comments received on conversion costs per facility. The previous analysis assumed conversion costs of $761,000 per facility (ICF 2014). Both small and larger businesses are assumed to realize annual savings due to the lower blowing agent costs.

[11] The small business threshold varied for specific industries based on their NAICS code.
[12] Assuming Solstice LBA costs between $14 and $17 per kilogram.
[13] The small business threshold varied for specific industries based on their NAICS code.

- **Polyurethane Integral Skin**— Companies still using HFC-134a are assumed to transition to CO_2. In light of public comments indicating that the conversion costs were not high enough, this analysis assumes capital costs to be between $184,000 and $220,000 for a typical firm (UNEP 2012, UNEP 2013a). Incremental annual operating costs are assumed to be zero.[14] The previous analysis assumed capital costs of $184,000 per facility (ICF 2014).

Commercial Refrigeration Assumptions

Cost assumptions for the commercial refrigeration sector are summarized below; for more detail, see *Economic Impact Screening Analysis for Regulatory Changes to the Listing Status of High-GWP Alternatives*.

New Systems:

- **Supermarket Systems and Remote Condensing Units**—Some movement out of high-GWP refrigerants (e.g., R-404A and R-507A) in new equipment has already been observed in the retail food industry, and industry pledges, such as those made by the Consumer Goods Forum to phase out HFC refrigerants in newly purchased equipment by the end of 2015, may serve to accelerate the transition out of HFC refrigerants. For the purposes of this analysis, it is assumed that the retail food industry is operating under business as usual conditions. As such, compliance costs are based on the assumption that end-users (e.g., supermarkets) will use R-407A in new systems in place of R-404A and R-507A, and that the incremental cost of using this alternative instead of R-404A or R-507A is negligible (i.e. zero dollars) since, given that the composition of R-404A and R-407A are similar, the cost of the refrigerant is assumed to be the same (EPA 2013). Therefore, no annual costs or savings are assumed.

  For businesses with an operational commercial refrigeration system that uses R-404A or R-507A, this regulation does not require that they retire their system or retrofit their system to use a different refrigerant. It also does not prevent them from maintaining or servicing their system. Therefore, end-users are not considered to be affected until they choose to purchase a new system anyway, at which point their choice of new refrigerant is impacted.

  The regulation also does not prescribe that any business transition to a particular, lower-GWP refrigerant or alternative technology, so additional costs businesses incur by choosing a different refrigerant/technology are not estimated in this analysis. For example, up to 50 percent of large supermarkets might choose to replace an old R-404A or R-507A system with a new transcritical CO_2 system that would have much less impact on climate than a new R-407A system. Those supermarkets are estimated to incur an additional total annualized upfront cost of about $979,000 and total annual cost savings of about $72,000 compared to the cost of choosing conventional HFC centralized direct expansion systems (EPA 2013). However neither the costs nor savings of such a choice is included in this analysis because it is not required by the rule.

[14] While an increase in operating costs may be experienced associated with the use of CO_2, these costs are not expected to outweigh the annual savings associated with the lower incremental blowing agent cost.

- **Stand-Alone Retail Food Equipment**— In the final rule, EPA considers stand-alone refrigeration to be: 1) stand-alone small medium temperature units, 2) stand-alone large medium temperature units, and 3) low temperature units. In light of public comments indicating that the conversion costs were not high enough, this analysis assumes that each establishment manufacturing the equipment will incur a one-time capital investment cost of $150,000 to $500,000 associated with using R-290 or a non-flammable alternative (e.g., R-450A) in place of an HFC refrigerant, which results in an annualized cost of about $14,000 to $47,000 per affected establishment.[15] The previous analysis assumed one-time capital investment costs at $50,000 per facility, which resulted in an annualized cost of about $4,700 per affected establishment (ICF 2014).

- **Refrigerated Vending Machines**— In light of public comments indicating that the conversion costs were not high enough, this analysis assumes that each establishment manufacturing the equipment will incur a one-time capital investment cost of $100,000 to $250,000 associated with using CO_2 in place of an HFC refrigerant, which results in an annualized cost of about $9,400 to $23,600 per affected establishment.[16] The previous analysis assumed one-time capital investment costs at $100,000 per facility, which resulted in an annualized cost of about $9,400 per affected establishment (ICF 2014).

Retrofits:

- **Supermarket Systems and Remote Condensing Units**—In the absence of this regulation, this analysis estimates that a number of companies would have CFC-12, R-502, or HCFC-22 supermarket systems or remote condensing units in operation in 2016 and 2018, respectively, that would be available for retrofitting—with R-404A, R-507A, or R-422D being the preferred retrofit refrigerant—and would thus be affected by this regulation.

  Compliance costs are based on the assumption that end-users would use R-407A as the retrofit refrigerant in place of R-404A and R-507A, and that the incremental cost of using this alternative instead of R-404A or R-507A is negligible (i.e. zero dollars) based on cost assumptions discussed above (EPA 2013). The EPA (2013) also assumes that there is a one-time conversion cost associated with performing a refrigerant retrofit on a remote retail food system. However, since this regulation does not require end-users to retrofit their equipment, but rather prohibits the use of certain refrigerants to be used as a retrofit, the labor costs associated with performing the retrofit itself are not a compliance cost of the rulemaking. Thus, these costs are not included in this analysis.

- **Stand-Alone Retail Food Equipment and Refrigerated Vending Machines**—This analysis assumes that stand-alone equipment using CFC-12, R-502, or HCFC-22 in operation by 2016 would not retrofit this equipment due to the high costs of retrofitting equipment relative to the cost of purchasing a new unit, and hence, would not need to be retrofitted. With regard to retrofitting for vending machines, based on the lifetime of the equipment and the direct transition from CFCs to HFCs in this end-use before 1996,

[15] Using a 7% discount rate.
[16] *Idem.*

the analysis assumes that no vending machines will have CFC-12, R-502, or HCFC-22 systems in operation in 2016 that would be available for retrofitting and hence, would not need to be retrofitted.

Results

Using the methodology and additional assumptions described above, Table 2 below summarizes the estimated number of businesses potentially affected by the rule as well as the estimated annualized costs by sector at a 7% discount rate. Table 3 summarizes the estimated annualized costs by sector at a 3% discount rate. As shown, while about 645,000 businesses are potentially subject to this rule, the analysis estimates that the rule is expected to result in changes in costs for less than 0.1% (or fewer than 200) of these businesses.

Using a 7% discount rate, total annualized compliance costs across affected businesses are estimated to range from $28.0 million to $50.6 million; total annual savings are estimated be about $19.3 million; thus total annualized upfront compliance costs and annual savings combined are estimated to range from $8.7 million to $42.7 million. Using a 3% discount rate, total annualized compliance costs across affected businesses are estimated to range from $19.5 million to $37.8 million; total annual savings are estimated be about $19.3 million; thus total annualized upfront compliance costs and annual savings combined are estimated to range from $0.2 million to $31.9 million. The previous analysis estimated total annualized compliance costs across affected businesses to be about $23.8 and $30.5 million, using a 3% and 7% discount rate, respectively; total annual savings were estimated to be about $25.1 million (for both discount rates); thus, annualized net compliance costs were estimated to be roughly -$1.4 and $5.4 million, respectively. (ICF 2014).

The majority of potentially affected businesses are in the commercial refrigeration sector, but it is important to note that these businesses will not be affected in a single year; instead, a small proportion of businesses are expected to be affected in each year over a 15 to 20 year period, as existing retail food equipment reaches end-of-life and businesses make choices about which alternative refrigerant to use in new systems or retrofits. Even if these businesses are affected, EPA assumes that most of them will switch to R-407A. Since the composition of R-404A and R-407A are similar, the cost of the refrigerant is the same. Therefore, no annual costs or savings are assumed for this change.

Table 2: Estimated Compliance Cost of the Regulatory Changes using a 7% Discount Rate

Sector	Estimated Number of Businesses Potentially Impacted by the Rule	Higher			Lower		
		Annualized Upfront Costs[a]	**Annual Savings[b]**	Annualized Upfront Cost and Annual Savings[d]	**Annualized Upfront Costs[a]**	**Annual Savings[b]**	Annualized Upfront Cost and Annual Savings[b]
Motor Vehicle Air Conditioning - Exports[e]	**240**	**$8,760,000**	**$0**	$8,760,000	**$0**	**$0**	**$0**
Aerosols	**<10**	**$1,040,000**	**($5,250,000)**	$0[d]	**$250,000**	**($5,250,000)**	**($5,000,000)**
Foams	**120**	**$38,990,000**	**($14,090,000)**	$32,120,000	**$27,200,000**	**($14,090,000)**	**$13,110,000**
Polystyrene foam product manufacturing	<10	$27,490,000	$0	$27,490,000	$17,640,000	$0	$17,640,000
Household refrigerator and freezer manufacturing	<10	$3,090,000	($6,600,000)	$0[d]	$2,580,000	($6,600,000)	($4,020,000)
Commercial and industrial refrigeration equipment manufacturing	50	$3,760,000	($7,480,000)	$0[d]	$3,130,000	($7,480,000)	($4,350,000)
Urethane and other foam product (except polystyrene) manufacturing	60	$4,640,000	($10,000)	$4,630,000	$3,850,000	($10,000)	$3,840,000
Commercial Refrigeration	**644,500[c]**	**$1,800,000**	**$0**	$1,800,000	**$570,000**	**$0**	**$570,000**
New equipment	**474,900**	**$1,800,000**	**$0**	$1,800,000	**$570,000**	**$0**	**$570,000**
Supermarket systems	29,300	$0	$0	$0	$0	$0	$0
Remote condensing units	445,500	$0	$0	$0	$0	$0	$0
Stand-alone equipment	30	$1,520,000	$0	$1,520,000	$450,000	$0	$450,000
Vending machines	10	$280,000	$0	$280,000	$110,000	$0	$110,000
Retrofits	**169,600**	**$0**	**$0**	$0	**$0**	**$0**	**$0**
Supermarket systems	10,500	$0	$0	$0	$0	$0	$0
Remote condensing units	159,100	$0	$0	$0	$0	$0	$0
Stand-alone equipment	0	$0	$0	$0	$0	$0	$0
Vending machines	0	$0	$0	$0	$0	$0	$0
ALL SECTORS	**644,800**	**$50,590,000**	**($19,340,000)**	**$42,690,000**	**$28,030,000**	**($19,340,000)**	**$8,680,000**

Totals may not sum due to independent rounding.

[a] Includes annualized upfront capital costs as well as recurring annual costs.

[b] Savings are shown as negative values; costs are shown as positive values.

[c] It is possible that some businesses will be affected for multiple types of equipment, resulting in a lower total number of discrete businesses affected by the rule. However, since it is not known how many businesses would be affected by multiple equipment types, the total maximum number of businesses that could be affected is shown.

[d] Annualized upfront costs and annual savings have been rounded to zero rather than a negative combined annualized upfront costs and annual savings for the higher estimate. The rounding assumes that at least some portion of the industry would have made the change even in the absence of the regulation.

[e] Costs are estimated on a per vehicle basis and are assumed for a subset of the export market only.

Table 3: Estimated Compliance Cost of the Regulatory Changes using a 3% Discount Rate

Sector	Higher			Lower		
	Annualized Upfront Costs[a]	**Annual Savings[b]**	Annualized Upfront Cost and Annual Savings[c]	**Annualized Upfront Costs[a]**	**Annual Savings[b]**	Annualized Upfront Cost and Annual Savings[b]
Motor Vehicle Air Conditioning – Exports[d]	**$8,760,000**	**$0**	**$8,760,000**	**$0**	**$0**	**$0**
Aerosols	**$860,000**	**($5,250,000)**	**$0[c]**	**$210,000**	**($5,250,000)**	**($5,040,000)**
Foams	**$26,940,000**	**($14,090,000)**	**$21,860,000**	**$18,910,000**	**($14,090,000**	**$4,820,000**
Polystyrene foam product manufacturing	$18,400,000	$0	$18,400,000	$11,810,000	$0	$11,810,000
Household refrigerator and freezer manufacturing	$2,280,000	($6,600,000)	$0[c]	$1,900,000	($6,600,000)	($4,700,000)
Commercial and industrial refrigeration equipment manufacturing	$2,790,000	($7,480,000)	$0[c]	$2,320,000	($7,480,000)	($5,160,000)
Urethane and other foam product (except polystyrene) manufacturing	$3,480,000	($10,000)	$3,470,000	$2,890,000	($10,000)	$2,880,000
Commercial Refrigeration	**$1,280,000**	**$0**	**$1,280,000**	**$400,000**	**$0**	**$400,000**
New equipment	**$1,280,000**	**$0**	**$1,280,000**	**$400,000**	**$0**	**$400,000**
Supermarket systems	$0	$0	$0	$0	$0	$0
Remote condensing units	$0	$0	$0	$0	$0	$0
Stand-alone equipment	$1,080,000	$0	$1,080,000	$320,000	$0	$320,000
Vending machines	$200,000	$0	$200,000	$80,000	$0	$80,000
Retrofits	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
Supermarket systems	$0	$0	$0	$0	$0	$0
Remote condensing units	$0	$0	$0	$0	$0	$0
Stand-alone equipment	$0	$0	$0	$0	$0	$0
Vending machines	$0	$0	$0	$0	$0	$0
ALL SECTORS	**$37,840,000**	**($19,340,000)**	**$31,910,000[c]**	**$19,530,000**	**($19,340,000)**	**$180,000**

Totals may not sum due to independent rounding.

[a] Includes annualized upfront capital costs as well as recurring annual costs.

[b] Savings are shown as negative values; costs are shown as positive values.

[c] Annualized upfront costs and annual savings have been rounded to zero rather than a negative combined annualized upfront costs and annual savings for the higher estimate. The rounding assumes that at least some portion of the industry would have made the change even in the absence of the regulation.

[d] Costs are estimated on a per vehicle basis and are assumed for a subset of the export market only.

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