

# Economic Impact Screening Analysis for Regulatory Changes to the Listing Status of High-GWP Alternatives used in Refrigeration and Air Conditioning, Foams, and Fire Suppression

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# Executive Summary

The Significant New Alternatives Policy (SNAP) Program is the U.S. Environmental Protection Agency's (EPA) program to evaluate and regulate substitutes under the Clean Air Act (CAA). Section 612(c) of the CAA authorizes the Agency to identify and publish lists of acceptable and unacceptable substitutes.

EPA is changing the listing status of certain high-GWP alternatives used in refrigeration and air conditioning, foams, and fire suppression. The final regulatory changes are summarized in Exhibit ES-1. To assist the Agency in satisfying its obligations under the Regulatory Flexibility Act (RFA) as amended by the Small Business Regulatory Enforcement Fairness Act (SBREFA), this report provides a screening analysis to assess the potential economic impacts on small entities associated with these changes.

Industries potentially affected by these regulatory changes were primarily identified by North American Industry Classification System (NAICS) codes. Small businesses in each affected industry were classified as such based on size definitions established by the Small Business Administration. Economic impacts on affected small businesses were calculated using a direct compliance cost method. The “sales test” was applied by estimating annualized compliance costs for affected small businesses as a percentage of those businesses’ annual sales.

This screening analysis finds that the rulemaking can be presumed to have ***no significant economic impact on a substantial number of small entities (SISNOSE)***. This screening analysis finds that this rulemaking can be presumed to have no SISNOSE for the following reasons:

- Roughly 89 small businesses could be subject to the rulemaking, although roughly 76% of small businesses subject to this rulemaking would be expected to incur compliance costs that are estimated to be less than 1% of annual sales.
- This analysis indicates that up to 21 of the 89 affected small businesses—or roughly 24%—could incur costs in excess of 1% of annual sales, and that up to 12 small businesses could incur costs in excess of 3% of annual sales.

Total annualized compliance costs across affected small businesses are estimated at approximately \$11.8 - \$14.4 million at a 7% discount rate, or \$11.5 - \$14.0 million at a 3% discount rate. The aggregated economic impacts on small businesses and SISNOSE determination are summarized in Table ES-1. Affected small businesses are

## Exhibit ES-1: Summary of Regulatory Changes Analyzed

- List unacceptable 24 hydrofluorocarbons (HFCs) and HFC blends for new centrifugal chillers in 2024.
- List unacceptable 24 HFCs and HFC blends for new positive displacement chillers in 2024.
- List unacceptable 24 HFCs and HFC blends for new refrigerated food processing and dispensing equipment in 2021.
- List unacceptable 28 HFCs and HFC blends for new household refrigerators and freezers in 2021.
- List unacceptable 21 HFCs and HFC blends for new cold storage warehouses in 2023.
- List unacceptable HFC-134a, HFC-245fa, and certain HFC blends in 1) rigid polyurethane high-pressure two component spray foam, 2) rigid polyurethane low - pressure two component spray foam, and 3) rigid polyurethane one-component foam sealants in 2020, 2021, and 2020, respectively, except for certain military, space- and aeronautics- related applications.
- List unacceptable methylene chloride in flexible polyurethane foam 30 days from date of publication.
- List unacceptable perfluorocarbons (C<sub>3</sub>F<sub>8</sub> and C<sub>4</sub>F<sub>10</sub>) one year after publication of a final rule for total flooding uses.

manufacturers of food processing and dispensing equipment, household refrigerators and freezers, cold storage refrigeration systems, and polyurethane foams.

**Table ES-1: Aggregated Economic Impacts on Small Businesses and SISNOSE Determination**

<b>Economic Impact</b>	<b>Number of Small Entities Subject to the Rule and Experiencing Given Economic Impact</b>	<b>Percent of All Small Entities Subject to the Rule That are Experiencing Given Economic Impact</b>
<b>Less than 1%</b> for all affected small entities <sup>a</sup>	<b>68</b>	<b>76.4%</b>
<b>1% or more</b> for one or more affected small entities <sup>b</sup>	<b>21</b>	<b>23.6%</b>
Greater than 3% for one or more affected small entities	12	13.5%

<sup>a</sup> Represents small entities affected with an economic impact equal to or lesser than 1% but greater than 0%.

<sup>b</sup> This category aggregates the number of small entities that would be expected to experience an impact of 1% to 3% with the number of small entities that would be expected to experience an impact of 3% or greater.

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# 1 Introduction

The Significant New Alternatives Policy (SNAP) Program is the U.S. Environmental Protection Agency's (EPA) program to evaluate and regulate substitutes under the Clean Air Act (CAA). In CAA Section 612(c), the Agency is authorized to identify and publish lists of acceptable and unacceptable substitutes.

EPA is changing the listing status of certain high-GWP alternatives used in refrigeration and air conditioning, foams, and fire suppression. The regulatory changes are shown in Table 1. To assist the Agency in satisfying its obligations under the Regulatory Flexibility Act (RFA) as amended by the Small Business Regulatory Enforcement Fairness Act (SBREFA),<sup>1</sup> this report provides a screening analysis to assess the potential economic impacts on small entities associated with these changes. This analysis finds that the final rulemaking can be presumed to have ***no significant economic impact on a substantial number of small entities (SISNOSE)***.

**Table 1: Unacceptable Substitutes and Substitutes Subject to Use Restrictions**

Sector	Description of Regulatory Change
<b>Refrigeration and Air-Conditioning</b>	For new centrifugal chillers, list unacceptable FOR12A, FOR12B, HFC-134a, HFC-227ea, HFC-236fa, HFC-245fa, R-125/134a/600a (28.1/70/1.9), R-125/290/134a/600a (55.0/1.0/42.5/1.5), R-404A, R-407C, R-410A, R-410B, R-417A, R-421A, R-422B, R-422C, R-422D, R-423A, R-424A, R-434A, R-438A, R-507A, RS-44 (2003 composition), and THR-03 in 2024.
	For new positive displacement chillers, list unacceptable FOR12A, FOR12B, HFC-134a, HFC-227ea, KDD6, R-125/134a/600a (28.1/70/1.9), R-125/290/134a/600a (55.0/1.0/42.5/1.5), R-404A, R-407C, R-410A, R-410B, R-417A, R-421A, R-422B, R-422C, R-422D, R-424A, R-434A, R-437A, R-438A, R-507A, RS-44 (2003 composition), SP34E, and THR-03 in 2024.
	For new retail food refrigeration (refrigerated food processing and dispensing equipment), list unacceptable HFC-227ea, KDD6, R-125/290/134a/600a (55.0/1.0/42.5/1.5), R-404A, R-407A, R-407B, R-407C, R-407F, R-410A, R-410B, R-417A, R-421A, R-421B, R-422A, R-422B, R-422C, R-422D, R-424A, R-428A, R-434A, R-437A, R-438A, R-507A, and RS-44 (2003 formulation) in 2021.
	For new household refrigerators and freezers, list unacceptable FOR12A, FOR12B, HFC-134a, KDD6, R-125/290/134a/600a (55.0/1.0/42.5/1.5), R-404A, R-407C, R-407F, R-410A, R-410B, R-417A, R-421A, R-421B, R-422A, R-422B, R-422C, R-422D, R-424A, R-426A, R-428A, R-434A, R-437A, R-438A, R-507A, RS-24 (2002 formulation), RS-44 (2003 formulation), SP34E, and THR-03 in 2021.
	For new cold storage warehouses, list unacceptable HFC-227ea, R-125/290/134a/600a (55.0/1.0/42.5/1.5), R-404A, R-407A, R-407B, R-410A, R-410B, R-417A, R-421A, R-421B, R-422A, R-422B, R-422C, R-422D, R-423A, R-424A, R-428A, R-434A, R-438A, R-507A, and RS-44 (2003 composition) in 2023.
<b>Foam Blowing</b>	For rigid polyurethane high-pressure two-component spray foam, list unacceptable HFC-134a, HFC-245fa, and blends thereof; blends of HFC-365mfc with at least 4% HFC-245fa, and commercial blends of HFC-365mfc with 7 to 13% HFC-227ea and the remainder HFC-365mfc; and Formacel TI in 2020, except as allowed under a narrowed use limit for military or space-and aeronautics-related applications.
	For rigid polyurethane low-pressure two-component spray foam, list unacceptable HFC-134a, HFC-245fa, and blends thereof; blends of HFC-365mfc with at least 4% HFC-245fa, and commercial blends of HFC-365mfc with 7 to 13% HFC-227ea and the remainder HFC-365mfc; and Formacel TI in 2021, except as allowed under a narrowed use limit for military or space-and aeronautics-related applications.

<sup>1</sup> For all rules subject to the RFA, a screening analysis is required to first determine what, if any, impact a rulemaking may have on small entities. For rules that pose “a significant economic impact on a substantial number of small entities,” an initial and final regulatory flexibility analysis is further required.

Sector	Description of Regulatory Change
	For rigid polyurethane one-component foam sealants, list unacceptable HFC-134a, HFC-245fa, and blends thereof; blends of HFC-365mfc with at least 4% HFC-245fa, and commercial blends of HFC-365mfc with 7 to 13% HFC-227ea and the remainder HFC-365mfc; and Formacel TI in 2020, except as allowed under a narrowed use limit for military or space-and aeronautics-related applications.
	In flexible polyurethane foam, list methylene chloride as unacceptable 30 days after publication of a final rule.
<b>Fire Suppression and Explosion Prevention</b>	For total flooding uses, list unacceptable perfluorocarbons (C <sub>3</sub> F <sub>8</sub> and C <sub>4</sub> F <sub>10</sub> ) one year after publication of a final rule.

The remainder of this report is organized as follows:

- **Chapter 2** presents the general approach and assumptions used to ensure consistency across the analysis, and also summarizes key assumptions made for each of the three affected industries.
- **Chapters 3, Error! Reference source not found., and 4** identify the small entities potentially affected by the regulatory changes and then estimate the economic impact on those affected entities for the refrigeration and air-conditioning, foams, and fire suppression industries, respectively.
- **Chapter 6** summarizes the aggregate small business impacts of the regulatory changes, along with a recommendation for certification based on a decision matrix for determining SISNOSE.

## 2 Summary of General Approach and Key Analytical Assumptions

To ensure consistency across the analysis, standard analytical steps and approaches were followed for each of the affected industries, as detailed below.

- **Step 1: Identify the types of industries expected to be directly impacted by the regulatory changes** - For all sectors, potentially affected industries were identified by North American Industry Classification System (NAICS) codes. Economic data about each affected industry—including number of firms and establishments<sup>2</sup> by employment or receipts size—was obtained from the U.S. Census Bureau’s Statistics of U.S. Businesses (<http://www.census.gov/econ/susb/>) and includes data from the 2012 Economic Census. The economic census profiles U.S. national and local economies every five years, and the 2012 data is the latest available at the time of this writing. By changing the listing status of certain high-GWP alternatives used in refrigeration and air-conditioning, foams, and fire suppression, this rulemaking potentially directly impacts small entities associated with these changes. Other entities (e.g., refrigeration and air conditioning technicians) may experience indirect effects as a result of market changes influenced by the rule, but these are not considered in this analysis. See *Cement Kiln Recycling Coalition v. EPA*, 255 F.3d 855, 869 (D.C. Cir. 2001), where the D.C. Circuit “has consistently rejected the contention that the RFA applies to small businesses indirectly affected by the regulation of other entities.”
- **Step 2: Determine what proportion of impacted industries are small businesses** - For all industries, small businesses were identified using the U.S. Small Business Administration’s table of small business size standards matched to NAICS codes. The version employed for this analysis became effective February 26, 2016.
- **Step 3: Determine what proportion of small businesses could be directly impacted** - This determination was made on an individual sector and end-use basis, taking into consideration whether the 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 regulations would come into effect.
- **Step 4: For the purposes of quantifying compliance costs, make assumptions about the alternatives that would likely be used in place of the HFCs affected by this rulemaking** - For the purposes of quantifying compliance costs, this analysis has made some assumptions regarding which alternatives are implemented in the transition away from the HFCs affected by this rulemaking. These assumptions are not intended to represent the range of available alternatives, or to imply that other alternatives are not available. For a more complete accounting of substitutes, refer to the lists of acceptable substitutes as published under EPA’s SNAP Program ([www.epa.gov/ozone/snap/](http://www.epa.gov/ozone/snap/)). For the purposes of this analysis, the assumption about the alternative modeled was made on an individual sector or end-use basis, relying primarily on assumptions in EPA’s Vintaging Model (EPA 2014) and lists of acceptable substitutes identified through EPA’s SNAP program.

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<sup>2</sup> The U.S. Census Bureau defines an establishment as a single physical location where business is conducted or where services or industrial operations are performed; a firm is a business organization consisting of one or more domestic establishments in the same state and industry that were specified under common ownership or control. The firm and the establishment are the same for single-establishment firms. For each multi-establishment firm, establishments in the same industry within a state are counted as one firm, and the firm employment and annual payroll are summed from the associated establishments.



- Step 5: Quantify the economic impact on small businesses** - This analysis uses the direct compliance cost method to quantify impacts. Direct compliance costs include capital, operating, maintenance, and other direct compliance costs associated with switching to alternatives as a result of the regulatory changes. These costs were annualized to calculate a metric that can be compared with annual sales in the next step of the analysis. Consistent with EPA's *Guidelines for Preparing Economic Analysis* (2010), capital costs were annualized over the expected lifetime of the capital equipment using the opportunity cost of capital (discount rate). This screening analysis uses a 3 percent and 7 percent discount rate, in line with OMB Circular A-94, which provides guidelines for discount rates in benefit-cost analyses of federal programs. Where applicable, annual non-capital compliance costs—such as ongoing operating and maintenance costs—are added to the annualized capital costs to yield a total annualized cost of compliance. All costs and savings values are expressed in constant year 2015 U.S. dollars, adjusted using the implicit GDP price deflator published by the U.S. Bureau of Economic Analysis. When available and appropriate, cost assumptions identified in EPA's report on *Global Mitigation of Non-CO<sub>2</sub> Greenhouse Gases: 2010-2030* (EPA 2013) and information from industry were employed. For sub-sectors for which these cost data were not estimated, other available sources were sought, as described in the individual sector chapters. It should be noted that all cost information reflects the current cost of compliance, and thus likely represents a higher-end estimate of the cost of compliance in the years in which the regulatory changes would become effective. For example, the price of alternative refrigerants and blowing agents would likely be expected to decrease over time.
- Step 6: Perform the sales test** - For this analysis, the “sales test” was applied, which calculates annualized compliance costs as a percentage of annual sales. For industries for which annual sales data was not available through the Economic Census, annual receipts or annual value of shipments<sup>3</sup> was utilized as a reasonable proxy. For the purposes of the sales test, annualized compliance costs were calculated using a 7% discount rate. Applying this sales test resulted in several possible outcomes apart from a positive percentage (such as 1% or 3%). In some cases, no small entities would be expected to be impacted by the rulemaking in a given NAICS code. In other cases, the annualized cost of compliance was expected to be zero because the cost of using alternative refrigerants or blowing agents was negligible (i.e. zero dollars). In these instances, the result is shown as 0%.

Chapters 3, 4, and 5 that follow further describe the specific data and assumptions that enable the estimation of the economic impact on small businesses in the industries potentially affected by this rulemaking. Table 2 summarizes some of these key assumptions by industry and end-use—including which affected chemicals are currently assumed to be in use in each end-use, and to which alternatives each end-use is assumed to transition—for the purposes of estimating costs. Table 2 also summarizes the types of entities expected to be directly impacted.

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<sup>3</sup> Total value of shipments includes the received or receivable net selling values of all products shipped (exclusive of freight and taxes).

**Table 2: Assumptions Concerning Affected Chemicals in Use, Alternatives Modeled, and Types of Entities Affected**

Sector	End Use		Affected Chemical(s) Assumed to Currently be in Use	Alternatives Modeled for the Cost Analysis <sup>a</sup>	Types of Entities Directly Affected
Refrigeration and Air- Conditioning	Centrifugal Chillers	New	HFC-134a, HFC-245fa	R-450A, R-513A, R-1233zd(E)	System manufacturers
	Positive Displacement Chillers	New	R-410A, R-407C, HFC-134a	R-450A, R-513A	System manufacturers
	Retail Food Refrigeration (refrigerated food processing and dispensing equipment)	New	R-404A	R-450A	System manufacturers
	Household Refrigerators and Freezers	New	HFC-134a	R-450A, R-513A	System manufacturers
	Cold Storage Warehouses	New	R-404A, R-507A	R-407F	System manufacturers
Foam	Rigid PU: high-pressure two-component spray foam		HFC-245fa	Hydrofluoroolefin (HFO)-1233zd(E)	Foam manufacturers
	Rigid PU: low-pressure two-component spray foam		HFC-134a, HFC-245fa	HFO-1234ze	Foam manufacturers
	Rigid PU: one-component foam sealants		HFC-134a	HFO-1234ze	Foam manufacturers
	Flexible PU		None	None	None
Fire Suppression and Explosion Prevention	Total Flooding		None	None	None

<sup>a</sup> As noted previously, for the purposes of quantifying compliance costs, this analysis has made some assumptions regarding which alternatives to model in the transition away from the affected HFCs. These assumptions are not intended to represent the entirety of available alternatives, or to imply that other alternatives are not available. For a fuller accounting of substitutes, please refer to the lists of acceptable substitutes as published under EPA's SNAP Program ([www.epa.gov/ozone/snap/](http://www.epa.gov/ozone/snap/)).

## 3 Refrigeration and Air Conditioning

### 3.1 Chillers (centrifugal and positive displacement)

The regulatory changes are expected to affect the chillers end-use, including centrifugal and positive displacement chillers. Specifically, the regulatory changes applicable to the chillers end-use include the following:

- For **new centrifugal chillers**, list unacceptable FOR12A, FOR12B, HFC-134a, HFC-227ea, HFC-236fa, HFC-245fa, R-125/134a/600a (28.1/70/1.9), R-125/290/134a/600a (55.0/1.0/42.5/1.5), R-404A, R-407C, R-410A, R-410B, R-417A, R-421A, R-422B, R-422C, R-422D, R-423A, R-424A, R-434A, R-438A, R-507A, RS-44 (2003 composition), and THR-03 in 2024.
- For **new positive displacement chillers**, list unacceptable FOR12A, FOR12B, HFC-134a, HFC-227ea, KDD6, R-125/134a/600a (28.1/70/1.9), R-125/290/134a/600a (55.0/1.0/42.5/1.5), R-404A, R-407C, R-410A, R-410B, R-417A, R-421A, R-422B, R-422C, R-422D, R-424A, R-434A, R-437A, R-438A, R-507A, RS-44 (2003 composition), SP34E, and THR-03 in 2024.

#### 3.1.1 Small Entities Potentially Subject to the Rulemaking

Chillers are used to regulate temperature and humidity in office buildings, hotels, hospitals, shopping centers, and other commercial buildings. Vapor-compression chillers, which have historically used ozone depleting substances (ODS) as their refrigerant, are designed with an electric motor that runs a compressor and are further classified by the type of compression system used: centrifugal or positive displacement. Centrifugal compressors have a typical cooling capacity between 750 and 10,000 kW, compared to positive displacement compressors which can serve between 50 and 750 kW (UNEP 2015b). Centrifugal chillers, therefore, have larger charge sizes than positive displacement chillers and are typically employed in larger buildings.

The economic impact of complying with the regulatory changes that impact new centrifugal and positive displacement chillers is expected to be incurred by manufacturers of new centrifugal and positive displacement chillers, including manufacturers of fully assembled chillers and manufacturers of chiller components (i.e., compressors or chiller shells).

The Department of Energy (DOE) identified domestic water- and evaporatively-cooled air conditioner manufacturers in a technical support document for a final rule on Commercial, Air Conditioning, and Water Heating Equipment (DOE 2011), including six centrifugal and positive displacement chiller manufacturers.<sup>4</sup> In addition to the DOE technical support document, three additional U.S. manufacturers of centrifugal and positive displacement chillers were identified through an online search.<sup>5</sup> In total, it is estimated that there are nine

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<sup>4</sup> DOE identified the following eight manufacturers of water- and evaporatively-cooled air conditioners: Aaon, Inc., Allied Thermal Systems, Carrier Corp. (United Technologies Corporation), Lennox International, Inc., Engineered Air, Thermoplus Air, Inc., Trane Inc. (Ingersoll Rand), and York International Corp. (Johnson Controls, Inc.). Six of these manufacturers (excluding Allied Thermal Systems and ThermoPlus Air) manufacture centrifugal and positive displacement chillers.

<sup>5</sup> The online search identified the following three additional manufacturers of centrifugal and positive displacement chillers: Danfoss, Emerson Electric, and Thermal Care (MRFI, Inc.).

manufacturers of centrifugal and positive displacement chillers in the United States. However, none of these manufacturers are small businesses, according to the metric used for this industry.

Centrifugal and positive displacement chiller manufacturers are matched to NAICS code 333415, *air-conditioning and warm air heating equipment and commercial and industrial refrigeration equipment manufacturing*. The small business threshold for this industry is defined as firms with 1,250 employees or fewer. Based on a review of U.S. Securities and Exchange Commission Form 10-K submissions, 2014 Company Annual Reports, and company websites for the nine identified centrifugal and positive displacement chiller manufacturers, eight of the nine manufacturers were found to exceed the small business threshold of 1,250 employees (Aaon 2015, Danfoss 2015, Emerson Electric 2015, Engineered Air 2015, Ingersoll Rand 2015, Johnson Controls 2015, Lennox International 2015, and United Technologies 2015) while one manufacturer is considered to be a small business (MFRI 2015). **Error! Not a valid bookmark self-reference.** below summarizes the estimated number of small businesses expected to be directly affected by the regulatory changes applicable to chillers.

**Table 3: Estimated Number of Chiller Equipment Manufacturing Small Businesses Affected**

NAICS Code	Industry Name	Estimated Number of Small Businesses Affected <sup>a</sup>	
		Centrifugal Chillers	Positive Displacement Chillers
333415	Air-conditioning and warm air heating equipment and commercial and industrial refrigeration equipment manufacturing	1 <sup>b</sup>	1 <sup>b</sup>

<sup>a</sup> The total number of firms in this industry is 729, of which 700 are assumed to be small businesses (U.S. Census Bureau 2012).

<sup>b</sup> The same small business is affected by both regulatory decisions.

### 3.1.2 Estimated Economic Impact on Affected Small Entities

This analysis assumes that positive displacement manufacturers and centrifugal chiller manufacturers will use R-450A or R-513A in place of R-410A/R-407C and HFC-134a, respectively. In addition, it is assumed that centrifugal manufacturers that manufacture low-pressure centrifugal chillers will transition to Solstice™-1233zd(E). R-450A and R-513A are considered a near drop-in replacement for HFC-134a chillers and thus do not require any significant changes to the chiller equipment (Honeywell 2015; DuPont 2014). Therefore, it is assumed that manufacturers will not incur any one-time capital costs associated with using R-450A or R-513A in place of HFC-134a in new centrifugal chillers or R-407C and R-410A in new positive displacement chillers. For manufacturers of low-pressure centrifugal chillers that transition to Solstice™-1233zd(E), it is assumed that manufacturers would incur a one-time capital cost of approximately \$51,000 to convert the production line, including purchasing a new refrigerant system and charging equipment (UNEP 2012). Current refrigerants used in low-pressure centrifugal chillers include HCFC-123 and HFC-245fa; use of HCFC-123 in new chiller equipment will be prohibited beginning in 2020.

Annual costs incurred by manufacturers of chillers are calculated based on the higher cost of R-450A, R-513A, and Solstice™-1233zd(E) relative to the cost of HFC-134a, R-407C, R-410A, and HFC-245fa. Specifically, ICF estimates that R-450A and R-513A cost roughly \$5-\$6 more per kilogram than HFC-134a and \$4-\$5 more per kilogram than R-407C and R-410A, and Solstice™-1233zd(E) costs approximately \$11-\$12 more per kilogram than HFC-245fa.

In the absence of this rulemaking, by 2024 it is assumed that 10% of new positive displacement and centrifugal chillers will have already transitioned away from HFCs. This assumption is based on the current commercial availability of R-513A and Solstice™-1233zd(E) chillers as well as commitments from chiller manufacturers to introduce low-GWP refrigerants in their product lines (White House 2015). Based on this and 2024 sales of centrifugal chillers and positive displacement chillers estimated by EPA’s Vintaging Model (EPA 2014), it is assumed that the small business manufacturer affected by the regulatory changes will sell roughly 545 centrifugal chillers and 2,681 positive displacement chillers on average in 2024. It is additionally assumed that approximately 41% of the centrifugal chillers will transition to Solstice™-1233zd(E) and 59% will transition to R-450A or R-513A. EPA’s Vintaging Model assumes an average charge size of 708 kg for centrifugal chillers and 283 kg for positive displacement chillers, yielding incremental costs of \$3,500 to \$4,200 for centrifugal chillers and \$1,100-\$1,400 for positive displacement chillers using R-450A or R-513A, and \$7,800 to \$8,500 for centrifugal chillers using Solstice™-1233zd(E), associated with charging the systems.<sup>6</sup>

As a result, it is estimated that the small businesses manufacturer of centrifugal chillers and positive displacement chillers could incur an annual cost of roughly \$2.9 million to \$3.3 million and roughly \$3.0 million to \$3.8 million associated with manufacturing centrifugal chillers and positive displacement chillers, respectively, as a result of the regulatory changes.<sup>7</sup> Table 4 below presents the estimated economic impact of the regulatory changes on small businesses in the chiller end-uses.

**Table 4: Estimated Economic Impact on Small Entities in the Chiller End-Use (Sales Test)**

NAICS Code	Industry Name	Annualized Compliance Cost as a Percentage of Average Annual Sales per Manufacturer	
		Centrifugal	Positive Displacement
333415	Air-conditioning and warm air heating equipment and commercial and industrial refrigeration equipment manufacturing	0.7%–0.8%	0.7%–0.9%

### 3.2 Retail Food Refrigeration (Food Processing and Dispensing Equipment)

The regulatory changes are expected to affect the retail food refrigeration end-use, including refrigerated food processing and dispensing equipment. Specifically, the regulatory decision applicable to this end-use includes the following:

- For **new retail food refrigeration** (refrigerated food processing and dispensing equipment), list unacceptable HFC-227ea, KDD6, R-125/290/134a/600a (55.0/1.0/42.5/1.5), R-404A, R-407A, R-407B, R-407C, R-407F, R-410A, R-410B, R-417A, R-421A, R-421B, R-422A, R-422B, R-422C, R-422D, R-424A, R-428A, R-434A, R-437A, R-438A, R-507A, and RS-44 (2003 formulation) in 2021.

<sup>6</sup> Chiller compressors can be charged at the manufacturing facility, shipped partially charged and filled on-site, or shipped dry and filled on site depending on the size and installation location of the system. For the purposes of this analysis, it is assumed that all charging costs will be incurred by the manufacturer, although it is likely that some of these costs would be passed on to the end-user.

<sup>7</sup> Costs are annualized assuming a 25 year lifetime. See Appendix A for the results of a sensitivity analysis associated with this assumption.

### 3.2.1 Small Entities Potentially Subject to the Rulemaking

Refrigerated food processing and dispensing equipment—including ice cream machines, “slushy” iced beverage dispensers, and refrigerated beverage dispensers—are self-contained units that cool and dispense food and beverages via a nozzle. They are typically found in small retail food facilities, including convenience stores, restaurants, cafeterias, hotels, schools, hospitals, and snack and beverage bars. Currently, equipment used for medium temperature applications (i.e., refrigerated beverage dispensers) use HFC-134a while equipment used for low temperature applications (i.e., frozen beverage dispensers and ice cream machines) use R-404A. Since HFC-134a may continue to be used in new equipment under the regulatory decision, only manufacturers of new low temperature refrigerated food processing and dispensing equipment are expected to be affected by the regulatory changes.

Manufacturers of refrigerated food processing and dispensing equipment were identified through an internet search. In total, 16 U.S. manufacturers of refrigerated food processing and dispensing equipment were identified.<sup>8</sup> Since this list may not be exhaustive, it is conservatively assumed that there are 20 manufacturers of refrigerated food processing and dispensing equipment in the United States. Manufacturers of refrigerated food processing and dispensing equipment are matched to NAICS code 333415, *air-conditioning and warm air heating equipment and commercial and industrial refrigeration equipment manufacturing*. The small business threshold for this industry is defined as an enterprise with 1,250 employees or fewer. Based on this, roughly 96% of firms in this industry are categorized as a small business.<sup>9</sup> By applying this percentage to the estimated number of refrigerated food processing and dispensing equipment manufacturers, it is estimated that there are 19 small business manufacturers of refrigerated food processing and dispensing equipment in the United States.

While it is possible that some manufacturers only produce medium temperature equipment, it is conservatively assumed that all 19 small business manufacturers of refrigerated food processing and dispensing equipment produce low temperature equipment, and therefore could be affected by the regulatory decision, as summarized below in Table 5.

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<sup>8</sup> Manufacturers include Alpine Freezer, Avantco Equipment, Bunn, Central Exclusive, Cornelius, Electro Freeze, Elmeco, Emery Thompson Machine & Supply Co., Eurodib, Grindmaster Cecilware, MegaLane, Omega, SaniServ, Spaceman, Stoelting, and Taylor Company.

<sup>9</sup> The Census Statistics of U.S. Businesses data does not disaggregate the number of firms with an employment size above 500 employees. Since it is not possible to know how many firms with >500 employees fall within the small business threshold (i.e., have <1,250 employees), for the purposes of this analysis, 50% of firms with >500 employees are assumed to be small businesses.

**Table 5: Estimated Number of Refrigerated Food Processing and Dispensing Equipment Manufacturing Small Businesses Affected**

NAICS Code	Industry Name	Estimated Number of Small Businesses Affected <sup>a</sup>
333415	Air-conditioning and warm air heating equipment and commercial and industrial refrigeration equipment manufacturing	19

<sup>a</sup> The total number of firms in this industry is 729, of which 700 are assumed to be small businesses (U.S. Census Bureau 2012).

### *3.2.2 Estimated Economic Impact on Affected Small Entities*

For the regulatory decision that affects refrigerated food processing and dispensing equipment, the potential economic impact on small businesses was calculated based on the assumption that all manufacturers of refrigerated food processing and dispensing equipment would continue to use HFC-134a in medium temperature applications and would use R-450A in low temperature applications in place of R-404A. R-450A was approved for use in new refrigerated food processing and dispensing equipment under EPA’s SNAP Program in 2014. Minimal changes to manufacturing processes and infrastructure are assumed to be required to use R-450A in place of R-404A in new low-temperature equipment, resulting in negligible associated upfront costs.<sup>10</sup>

Annual costs incurred by manufacturers of refrigerated food processing and dispensing equipment are calculated based on the higher cost of R-450A relative to the cost of R-404A. Assuming that refrigerated food processing and dispensing equipment contains 1 kg of R-404A, it is conservatively estimated that manufacturers will incur an incremental cost of \$4-5 for each piece of equipment they produce (UNEP 2012; Alpine Freezer 2015). With units estimated to sell for \$10,000 a piece on average—based on the fact that this equipment ranges in price from roughly \$1,000 to \$20,000 (Webstaurant Store 2015a; Webstaurant Store 2015b; Central Restaurant Products 2015)—small business manufacturers are estimated to incur on average an annual incremental cost of roughly \$200-\$200,000, depending on the size of the firm.<sup>11,12</sup>

For manufacturers of refrigerated food processing and dispensing equipment affected by the regulatory decision, average annual sales per firm were calculated by dividing total value of receipts (as a proxy for sales) by the number of firms for each small business establishment size (e.g., 0-4 employees, 5-9 employees, 10-19 employees, etc.). Because average annual sales were calculated by establishment size, a range is provided for annual compliance costs as a percentage of annual sales. Table 6 below presents the estimated economic impact of the regulatory decision on small businesses in the retail food refrigeration end-use.

<sup>10</sup> R-450A is used as a proxy R-404A drop-in replacement refrigerant in this analysis. It is assumed that by 2021, a similar HFC/HFO refrigerant blend that is a drop-in replacement for R-404A will be available for use in low-temperature refrigerated food processing and dispensing equipment (Honeywell 2015). It is further assumed that refrigerant costs will be similar to that identified for R-450A.

<sup>11</sup> To estimate the total incremental cost per company, NAICS data was used to calculate the average value of shipments per firm for each small business establishment size (e.g., 0-4 employees, 5-9 employees, 10-19 employees, etc.). This information was then used to estimate the number of units sold by each firm on average by firm size.

<sup>12</sup> For the purposes of this analysis, it is assumed that all refrigerant costs will be incurred by the manufacturer, although it is possible that some of these costs would be passed on to the end-user.



**Table 6: Estimated Economic Impact on Small Entities in the Retail Food Refrigeration End-Use (Sales Test)**

NAICS Code	Industry Name	Annualized Compliance Cost as a Percentage of Average Annual Sales per Firm
333415	Air-conditioning and warm air heating equipment and commercial and industrial refrigeration equipment manufacturing	<0.1%

### 3.3 Household Refrigerators and Freezers

The regulatory changes are expected to affect the household refrigeration end-use. Specifically, the regulatory decision applicable to the household refrigeration end-use includes the following:

- For **new household refrigerators and freezers**, list unacceptable FOR12A, FOR12B, HFC-134a, KDD6, R-125/290/134a/600a (55.0/1.0/42.5/1.5), R-404A, R-407C, R-407F, R-410A, R-410B, R-417A, R-421A, R-421B, R-422A, R-422B, R-422C, R-422D, R-424A, R-426A, R-428A, R-434A, R-437A, R-438A, R-507A, RS-24 (2002 formulation), RS-44 (2003 formulation), SP34E, and THR-03 in 2021.

#### 3.3.1 Small Entities Potentially Subject to the Rulemaking

Household refrigeration, including household refrigerators and freezers, is primarily intended for residential use, but can also be found outside a home, for example, in an office building break room. There are three main product categories of household refrigeration: refrigerators, freezers, and refrigerator-freezers. As the equipment design in all of these applications is very similar, this analysis does not distinguish between the main product categories of household refrigeration.

The economic impact of complying with the regulatory decision that impacts new household refrigeration equipment is expected to be incurred by manufacturers of new household refrigerators, freezers, and refrigerator-freezers.

Manufacturers of household refrigeration equipment are matched to NAICS code 335222, *household refrigerator and home freezer manufacturing*. Within this NAICS code, there are 23 manufacturers of household refrigeration equipment (U.S. Census Bureau 2012). Of those, 20 are classified as small businesses based on the size threshold for this industry (i.e., firms with 1,250 employees or fewer).<sup>13</sup> Table 7 below summarizes the estimated number of small businesses expected to be directly affected by the regulatory decision that is applicable to household refrigeration equipment.

**Table 7: Estimated Number of Household Refrigeration Equipment Manufacturing Small Businesses Affected**

NAICS Code	Industry Name	Estimated Number of Small Businesses Affected <sup>a</sup>
335222	Household refrigerator and home freezer manufacturing	20

<sup>a</sup> The total number of firms in this industry is 23, of which 20 are assumed to be small businesses (U.S. Census Bureau 2012).

<sup>13</sup> The Census Statistics of U.S. Businesses data does not disaggregate the number of firms with an employment size above 500 employees. Since it is not possible to know how many firms with >500 employees fall within the small business threshold (i.e., have <1,250 employees), for the purposes of this analysis, 50% of firms with >500 employees are assumed to be small businesses.



### 3.3.2 Estimated Economic Impact on Affected Small Entities

The potential economic impact on small businesses to comply with the regulatory decision was calculated based on the assumption that household refrigeration manufacturers would use R-450A or R-513A in place of HFC-134a in new equipment. The economic impact of this change is discussed further below.

R-450A and R-513A, which are considered near drop-in replacements for HFC-134a (Honeywell 2015; DuPont 2014), were SNAP-approved in 2014 and 2015, respectively, for use in new and retrofitted household refrigerators. Given that no significant changes to the equipment are required, it is assumed that manufacturers will not incur any one-time capital costs associated with using R-450A or R-513A in place of HFC-134a.

Annual costs incurred by manufacturers of household refrigerators and freezers are calculated based on the higher cost of R-450A and R-513A relative to the cost of HFC-134a. Specifically, ICF estimates that R-450A and R-513A cost roughly \$5-\$6 more per kilogram than HFC-134a. Assuming an average charge size of 0.16 kg (EPA 2014), it is estimated that each manufacturer of household refrigerators and freezers could incur an annual cost of roughly \$1,400 to \$1.7 million, depending on the size of the firm.<sup>14,15</sup>

The economic impact per firm was calculated by dividing estimated receipts (as a proxy for sales) by the number of firms for each small business establishment size (e.g., 0-4 employees, 5-9 employees, 10-19 employees, etc.). Because a range of costs was used in the calculations, a range is provided for annual compliance cost as a percentage of average annual sales per manufacturer. In general, annual compliance costs represent a higher percentage of annual sales for smaller establishments. Table 8 below presents the estimated economic impact of the regulatory decision on small businesses in the household refrigeration sector.

**Table 8: Estimated Economic Impact on Small Entities in the Household Refrigeration Sector (Sales Test)**

NAICS Code	Industry Name	Annualized Compliance Cost as a Percentage of Average Annual Sales per Firm
335222	Household refrigerator and home freezer manufacturing	0.3%–0.3%

## 3.4 Cold Storage Warehouses

The regulatory changes are expected to affect the cold storage warehouse end-use, including manufacturers of cold storage refrigeration systems. Specifically, the regulatory decision applicable to this end-use includes the following:

- For **new cold storage warehouses**, list unacceptable HFC-227ea, R-125/290/134a/600a (55.0/1.0/42.5/1.5), R-404A, R-407A, R-407B, R-410A, R-410B, R-417A, R-421A, R-421B, R-422A, R-422B, R-422C, R-422D, R-423A, R-424A, R-428A, R-434A, R-438A, R-507A, and RS-44 (2003 composition) in 2023.

<sup>14</sup> Annual costs are based on estimated 2021 sales of household refrigerators and freezers (approximately 11 million units) using EPA's Vintaging Model (EPA 2014). This analysis assumes that refrigerator sales are proportionally distributed among manufacturers based on average sales across each establishment size category.

<sup>15</sup> For the purposes of this analysis, it is assumed that all refrigerant costs will be incurred by the manufacturer, although it is possible that some of these costs would be passed on to the end-user.

### 3.4.1 Small Entities Potentially Subject to the Rulemaking

The cold storage warehouse industry is comprised of refrigeration system manufacturers and cold storage warehouse operators. Cold storage refrigeration system manufacturers are expected to be impacted by the regulatory decision affecting new systems.

Thirty-five cold storage refrigeration system manufacturers were identified through an internet search, including review of the Global Cold Chain Alliance directory (GCCA 2013). Since this list is not assumed to be exhaustive, it is conservatively assumed that there are 40 manufacturers of cold storage refrigeration systems in the United States. Manufacturers of cold storage refrigeration systems are matched to NAICS code 333415, *Air-Conditioning and Warm Air Heating Equipment and Commercial and Industrial Refrigeration Equipment Manufacturing*. The small business threshold for this industry is defined as a firm with less than 1,250 employees and, roughly 96% of establishments in this industry are categorized as a small business.<sup>16</sup> By applying this percentage to the estimated number of cold storage refrigeration system manufacturers, it is estimated that there are 38 small business manufacturers of cold storage refrigeration system in the United States.

It is estimated that 90 percent of the cold storage industry currently uses ammonia in their refrigeration systems (Accelerate America 2015). Ammonia is most commonly used in large central systems that are typically found in warehouses greater than 200,000 square feet (EPA 2013). The remaining 10 percent of the market is assumed to use fluorinated refrigerants—historically chlorofluorocarbon (CFC)-12, R-502, and HCFC-22, with R-404A and R-507A being used in new equipment entering the market today (EPA 2014). The portion of the cold storage market that uses fluorinated refrigerants is assumed to use mostly packaged systems (i.e., self-contained systems that combine an evaporator, compressor, and condenser in one frame). Packaged systems are factory-built and commonly installed on the roof of small refrigerated warehouses with capacities ranging from 20 kW to 750 kW (Cole 2004; Emerson Climate 2014). Based on the current refrigerant use of the industry, it is assumed that 10 percent of the small business cold storage refrigeration system manufacturers, or four small businesses, produce packaged systems with fluorinated refrigerants and therefore would be affected by the regulatory changes.

Table 9 below summarizes the number of cold storage small businesses that are expected to be affected by the regulatory decision.

**Table 9: Estimated Number of Cold Storage Small Businesses Affected**

NAICS	Industry Name	Estimated Number of Small Businesses Affected
333415	Air-Conditioning and Warm Air Heating Equipment and Commercial and Industrial Refrigeration Equipment Manufacturing	4

<sup>16</sup> The Census Statistics of U.S. Businesses data does not disaggregate the number of firms with an employment size above 500 employees. Since it is not possible to know how many firms with >500 employees fall within the small business threshold (i.e., have <1,250 employees), for the purposes of this analysis, 50% of firms with >500 employees are assumed to be small businesses.

### 3.4.2 Estimated Economic Impact on Affected Small Entities

The potential economic impact on small businesses for complying with the regulatory decision was calculated based on the assumption that cold storage system manufacturers would use R-407F in place of R-404A and R-507A in new systems. The economic impact of the regulatory decision is discussed further below.

R-407F is considered a viable alternative to R-404A and R-507A in both medium and low temperature applications in new systems (Honeywell 2014). Given that R-407A can be used interchangeably with both R-404A with only minor system adaptations, no upfront costs are assumed to be incurred by manufacturers when transitioning from R-404A or R-507A to R-407A in new cold storage refrigeration systems. In regards to annual costs, R-407F—a blend of HFC-134a, HFC-32, and HFC-125—is estimated to cost between \$7.60 and \$9.60 per kilogram, while R-404A and R-507A are estimated to cost between \$8 and \$10 per kilogram (UNEP 2012).<sup>17</sup> At the same time, the charge size of R-407F systems is assumed to be 1.07 times greater than the charge sizes of R-404A and R-507A systems (Honeywell 2012). As a result, it is estimated that using R-407F in new systems in place of R-404A and R-507A will cost each manufacturer roughly \$20,000 to \$40,000 per year.<sup>18,19</sup>

The economic impact per firm was calculated by dividing estimated receipts (as a proxy for sales) by the number of firms for each small business establishment size (e.g., 0-4 employees, 5-9 employees, 10-19 employees, etc.). Because a range of costs was used in the calculations, a range is provided for annual compliance cost as a percentage of average annual sales per business. In general, annual compliance costs represent a higher percentage of annual sales for smaller establishments. Table 10 below presents the estimated economic impact of the regulatory decision on small businesses in the cold storage industry.

**Table 10: Estimated Economic Impact on Cold Storage Small Businesses (Sales Test)**

NAICS Code	Industry Name	Annualized Compliance Cost as a Percentage of Annual Sales per Small Business
333415	Air-Conditioning and Warm Air Heating Equipment and Commercial and Industrial Refrigeration Equipment Manufacturing	<0.1%–6.2%

## 4 Foam Blowing

The regulatory changes are expected to affect the foam manufacturing industry, including manufacturers of polyurethane (PU) foam products. Specifically, the regulatory changes applicable to the foam blowing sector include the following:

- For **rigid PU HP two-component spray foam**, list unacceptable HFC-134a, HFC-245fa, and blends thereof; blends of HFC-365mfc with at least 4% HFC-245fa, and commercial blends of HFC-365mfc with 7 to 13%

<sup>17</sup> Cost data was not available for R-507A, but the analysis assumes the costs of R-404A and R-507A are comparable due to their components and market penetration. R-404A is a refrigerant blend comprised of 44% HFC-125, 52% HFC-143a, and 4% HFC-134a. R-507A is a refrigerant blend comprised of 50% HFC-125 and 50% HFC-143a.

<sup>18</sup> Based on EPA's Vintaging Model, it is assumed that in the absence of this rulemaking, roughly 520 MT of R-404A or R-507A would be used in new cold storage refrigeration systems in 2021.

<sup>19</sup> For the purposes of this analysis, it is assumed that all refrigerant costs will be incurred by the manufacturer, although it is possible that some of these costs would be passed on to the end-user.

HFC-227ea and the remainder HFC-365mfc; and Formacel TI in 2020, except as allowed under a narrowed use limit for military or space-and aeronautics–related applications.

- For **rigid PU LP two-component spray foam**, list unacceptable HFC-134a, HFC-245fa, and blends thereof; blends of HFC-365mfc with at least 4% HFC-245fa, and commercial blends of HFC-365mfc with 7 to 13% HFC-227ea and the remainder HFC-365mfc; and Formacel TI in 2021, except as allowed under a narrowed use limit for military or space-and aeronautics–related applications.
- For **rigid PU OCF sealants**, list unacceptable HFC-134a, HFC-245fa, and blends thereof; blends of HFC-365mfc with at least 4% HFC-245fa, and commercial blends of HFC-365mfc with 7 to 13% HFC-227ea and the remainder HFC-365mfc; and Formacel TI in 2020, except as allowed under a narrowed use limit for military or space-and aeronautics–related applications.
- In **flexible PU foam**, list methylene chloride as unacceptable 30 days after publication of a final rule.

#### 4.1 Small Entities Potentially Subject to the Rulemaking

The foam types affected by the regulatory changes are matched to NAICS code 326150, *urethane and other foam product (except polystyrene) manufacturing*. However, NAICS code 326150 covers a broader industry than the specific foam end-uses addressed in the regulatory changes. Thus, the number of manufacturers potentially affected by the regulatory changes by relevant foam type was determined based on market penetration data from EPA’s Vintaging Model (EPA 2014). The Vintaging Model defines the market for PU spray foam, PU one-component foam (OCF), and flexible PU (slabstock and molded), among other foam end-uses. Since HP two-component and LP two-component spray foams are not defined by the Vintaging Model, expert judgement was used to further break out the PU spray foam market by sub-type (Jeffs 2015).

Based on the Vintaging Model, it is estimated that 92% and 17% of the spray foam (i.e., HP two-component and LP two-component) and OCF markets, respectively, currently use HFC-134a, HFC-245fa, or other HFCs/HFC blended blowing agents, namely HFC-365mfc with HFC-245fa or HFC-227ea. Flexible PU (slabstock and molded) is assumed to use only hydrocarbon blowing agents (i.e., methylene chloride is not currently in use in this foam type).

Some movement away from high-GWP blowing agents (e.g., HFC-134a, HFC-245fa) has already been observed in the spray foam insulation industry, and the industry pledges to transition away from HFC blowing agents in new foam products may serve to accelerate the transition out of HFC blowing agents (White House 2015). Assuming that the industry is operating under business as usual conditions, this analysis estimates that in the absence of this rulemaking, approximately 10% of the HP two-component and LP two-component industry will transition away from HFC blowing agents by 2020 and 2021, respectively.

By combining these assumptions, the percent of entities identified by NAICS code 326150 that are assumed to be affected by each regulatory decision can be calculated, as summarized below in Table 11.

**Table 11: Assumptions about the Percentage of Affected Entities in NAICS Code 326150**

Relevant Foam Types	% of the Foam Blowing Industry <sup>a</sup>	% of Foam Type Using Blowing Agents Listed as Unacceptable	% of Entities Assumed to be Affected
Rigid PU: HP two-component spray foam	10%	83%	8.6%
Rigid PU: LP two-component spray foam	2.2%	83%	1.8%
Rigid PU: OCF sealants	0.2%	17%	<0.1%
Flexible PU: slabstock and molded	14%	0%	0%

<sup>a</sup> The foam blowing industry includes all foam types covered under NAICS code 326150.

The small business threshold for the *urethane and other foam product (except polystyrene) manufacturing* industry is defined as a firm with fewer than 750 employees. Table below presents the number of small businesses estimated to be directly affected by the regulatory changes.<sup>20</sup>

**Table 12: Estimated Number of Small Business Foam Manufacturers Affected by the Regulation**

NAICS Code	Industry Name	Estimated Number of Small Businesses Affected <sup>a</sup>			
		Rigid PU			Flexible PU
		HP Spray	LP Spray	OCF	
326150	Urethane and other foam product (except polystyrene) manufacturing	36	8	1	0

<sup>a</sup> The total number of firms in this industry is 446, of which 422 are characterized as small businesses (U.S. Census Bureau 2012).

## 4.2 Estimated Economic Impact on Affected Small Entities

This section summarizes the estimated economic impact of the regulatory changes on PU manufacturers. Where available and appropriate, compliance costs were estimated based on industry input received in comments on EPA's rulemaking, *Protection of Stratospheric Ozone: Change of Listing Status for Certain Substitutes under the Significant New Alternatives Policy Program* (79 FR 46126), EPA's report on *Global Mitigation of Non-CO<sub>2</sub> Greenhouse Gases: 2010-2030* (EPA 2013), and recently released public information (e.g., private sector commitments and executive actions to reduce consumption of HFCs).

Table 13 presents a summary of the annualized compliance costs as a percentage of the average annual sales for each foam type. Average annual sales per firm were calculated by dividing total value of receipts (as a proxy for sales) by the number of firms, for each small business establishment size (e.g., 0-4 employees, 5-9 employees, 10-19 employees, etc.). Because average annual sales were calculated by establishment size, a range is provided for annual compliance costs as a percentage of annual sales. The specific assumptions used for each foam type to estimate annualized compliance costs are presented after the table.

<sup>20</sup> The Census Statistics of U.S. Businesses data does not disaggregate the number of firms with an employment size above 500 employees. Since it is not possible to know how many firms with >500 employees fall within the small business threshold (i.e., have <750 employees), for the purposes of this analysis, 50% of firms with >500 employees are assumed to be small businesses.

**Table 13: Estimated Economic Impact on Small Businesses in the Foam Blowing Sector (Sales Test)**

NAICS Code	Industry Name	Annualized Compliance Cost as a Percentage of Annual Sales per Small Business			
		Rigid PU			Flexible PU
		HP Spray	LP Spray	OCF	
326150	Urethane and other foam product (except polystyrene) manufacturing	<0.1%–3.9%	0.2%–7.8%	<0.1%–3.9%	0% <sup>a</sup>

<sup>a</sup> Because methylene chloride is not currently in use, annual compliance costs are assumed to be zero.

#### 4.2.1 High-Pressure Two-Component Spray Foam

It is assumed that companies still using HFC-134a, HFC-245fa, and blends thereof in HP two-component spray foam would transition to Solstice™ Liquid Blowing Agent (LBA) (1233zd(E), *trans*-1-chloro-3,3,3-trifluoroprop-1-ene), which is commercially available in the United States (and has been since 2013). Capital costs for transitioning to Solstice™ LBA are assumed to be \$200,000–\$300,000 per facility, associated with the cost of formulation development and compliance testing. These costs are annualized assuming a facility lifetime of 25 years.<sup>21</sup> No incremental operating costs are assumed.<sup>22</sup>

#### 4.2.2 Low-Pressure Two-Component Spray Foam

Companies still using HFC-134a, HFC-245fa, and blends thereof in LP two-component spray foam are assumed to transition to Solstice™ Gaseous Blowing Agent (GBA) (HFO-1234ze). Reformulation of this foam type requires many iterative steps and manufacturers are experiencing technical issues with shelf-life stability caused by chemical interaction issues within the formulation. To successfully adopt an alternative blowing agent in LP two-component spray foams and develop a quality product, manufacturers will need to reformulate their systems to meet specific performance requirements and physical properties, and also conduct required field testing and certification. Capital costs for transitioning to HFO-1234ze are assumed to be \$500,000–\$600,000 per facility to cover the cost of extensive formulation development and compliance testing. These costs are annualized assuming a facility lifetime of 25 years.<sup>23</sup> No incremental operating costs are assumed.<sup>24</sup>

#### 4.2.3 One Component Foam Sealants

Companies still using HFC-134a and blends thereof in OCF sealants are expected to transition to Solstice™ GBA (HFO-1234ze), which is currently commercially available for use as a blowing agent in OCF in the United States. Capital costs for transitioning to HFO-1234ze are assumed to be \$200,000–\$300,000 per facility to cover the cost

<sup>21</sup> See Appendix A for the results of a sensitivity analysis associated with this assumption.

<sup>22</sup> Cost savings may be associated with the increase in yield (product coverage) and R-value (insulation value) of the blowing agent (estimated to equal approximately \$1.60 per kilogram of blowing agent). These savings are not accounted for in this direct compliance cost approach.

<sup>23</sup> See Appendix A for the results of a sensitivity analysis associated with this assumption.

<sup>24</sup> Cost savings may be associated with the increase in yield (product coverage) and R-value (insulation value) of the blowing agent (estimated to equal approximately \$3.10 per kilogram of blowing agent). These savings are not accounted for in this direct compliance cost approach.

of formulation development and compliance testing. These costs are annualized assuming a facility lifetime of 25 years.<sup>25</sup> No incremental operating costs were assumed.<sup>26</sup>

#### 4.2.4 Flexible Polyurethane Foam

Methylene chloride is not known to be used in any flexible PU foam applications. This foam type is currently only manufactured in the United States using hydrocarbons. Therefore, prohibiting the use of methylene chloride in this end-use is not expected to impact small businesses. The regulatory decision would serve to prevent uptake of methylene chloride into this foam end-use subsector.

## 5 Fire Suppression and Explosion Prevention

The regulatory changes are expected to affect the fire suppression and explosion protection industry, including manufacturers of total flooding systems. Specifically, the regulatory decision applicable to the fire suppression sector includes the following:

- For **total flooding uses**, list unacceptable perfluorocarbons (C<sub>3</sub>F<sub>8</sub> and C<sub>4</sub>F<sub>10</sub>) one year after publication of a final rule.

### 5.1 Small Entities Potentially Subject to the Rulemaking

The industry affected by the regulatory changes to the fire suppression sector is matched to NAICS code 3399991, *fire extinguishing equipment, hand-portable and fixed-system (excluding water sprinkler systems), including parts and attachments, manufacturing*. The small business threshold for this industry is defined as a firm with fewer than 750 employees.

Based on EPA’s Vintaging Model, it is estimated that 0.2% of the market uses HFC-23 in total flooding systems in 2015, with the remaining using halon 1301, other HFCs, and agents with zero ODP and low GWP, including fluoroketone, inert gas, CO<sub>2</sub>, powdered aerosols, foam, and water mist (EPA 2014). It is additionally estimated that fire suppression agents with zero ODP and low GWP—including water, CO<sub>2</sub>, and dry chemical—currently occupy over 80% of the available streaming applications, with the remaining 20% of the market using halon 1211, Halotron, and HFCs (e.g., HFC-236fa). Since PFCs (i.e., C<sub>3</sub>F<sub>8</sub> and C<sub>4</sub>F<sub>10</sub>) and SF<sub>6</sub> are not assumed to currently be used in new fire extinguishing equipment and the portion of the market using HFC-23 is assumed to be using it for explosion inerting for oil and gas processing facilities, no small businesses are estimated to be affected by the regulatory changes, as shown in Table .

**Table 14: Estimated Number of Small Businesses Manufacturing Fire Suppression Equipment Affected**

NAICS Code	Industry Name	Estimated Number of Small Businesses Affected by the Regulation <sup>a</sup>
3399991	Fire extinguishing equipment, hand-portable and fixed-system (excluding water sprinkler systems), including parts and attachments, manufacturing	0

<sup>a</sup> The total number of firms in this industry is 29, of which 25 are characterized as small businesses (U.S. Census Bureau 2012).

<sup>25</sup> See Appendix A for the results of a sensitivity analysis associated with this assumption.

<sup>26</sup> Cost savings may be associated with the increase in yield (product coverage) of the blowing agent (estimated to equal roughly \$3.10 per kilogram of blowing agent). These savings are not accounted for in this direct compliance cost approach.



# 5.2 Estimated Economic Impact on Affected Small Entities

Because no small businesses are expected to be affected by the regulatory changes, the annual compliance cost as a percentage of average sales per firm is zero, as shown in Table below.

Table 15: Estimated Economic Impact on Small Businesses in the Fire Suppression Sector (Sales Test)

NAICS	Industry Name	Annualized Compliance Cost as a Percentage of Annual Sales per Small Business
3399991	Fire extinguishing equipment, hand-portable and fixed-system (excluding water sprinkler systems), including parts and attachments, manufacturing	0% <sup>a</sup>

<sup>a</sup> Because PFCs are not currently in use, annual compliance costs are assumed to be zero.



## 6 Conclusion

This screening analysis finds that the regulatory changes can be presumed to have ***no significant economic impact on a substantial number of small entities (SISNOSE)***, as described below. The discussion below describes the decision matrix used to make this determination, as well as the aggregated small business impacts.

### 6.1 Decision Regarding Significant Economic Impact on a Substantial Number of Small Entities

Using economic threshold levels set conservatively at 1% and 3% of sales, consistent with similar analyses on other Title VI rules, this screening analysis finds that the regulatory changes can be presumed to have ***no SISNOSE***. These thresholds are set conservatively because the decision would affect small businesses in a range of different industries, which may have significantly different profit margins and abilities to pass compliance costs along to customers.

### 6.2 Aggregated Small Business Impacts of Regulatory Changes

Table summarizes the total number of small businesses that are expected to be subject to the regulatory changes, as well as the total economic impact and the annualized compliance costs as a percentage of total annual sales on those small businesses using a 7% discount rate. Table summarizes the total number of small businesses that are expected to be subject to the regulation, as well as the total economic impact and the annualized compliance costs as a percentage of total annual sales on those small businesses using a 3% discount rate.

**Table 16: Summary of the Small Business Impact at 7% Discount Rate**

Sector	NAICS Code	Industry	Estimated Number of Small Businesses Affected by the Rule	Total Annualized Economic Impact on Small Businesses		Annualized Compliance Cost as a Percentage of Total Annual Sales	
				Lower	Higher	Lower	Higher
Chillers	333415	Air-conditioning and warm air heating equipment and commercial and industrial refrigeration equipment manufacturing	1	\$2,880,000	\$3,260,000	0.7%	0.8%
	333415	Air-conditioning and warm air heating equipment and commercial and industrial refrigeration equipment manufacturing		\$3,030,000	\$3,790,000	0.7%	0.9%
Retail Food	333415	Air-conditioning and warm air heating equipment and commercial and industrial refrigeration equipment manufacturing	19	\$70,000	\$90,000	<0.1%	<0.1%
Household Refrigeration	335222	Household refrigerator and home freezer manufacturing	20	\$4,590,000	\$5,500,000	0.3%	0.3%
Cold Storage	333415	Air-conditioning and warm air heating equipment and commercial and industrial refrigeration equipment manufacturing	4	\$70,000	\$140,000	<0.1%-3.0%	<0.1%-6.2%
Foam	326150	Urethane and other foam product (except polystyrene) manufacturing	36	\$800,000	\$1,200,000	<0.1%-2.6%	0.1%-3.9%
			8	\$400,000	\$500,000	0.2%-6.5%	0.3%-7.8%
			1	\$3,000	\$5,000	<0.1%-2.3%	0.1%-3.9%
			0	\$0	\$0	NA	NA
Fire Suppression	3399991	Fire extinguishing equipment, hand-portable and fixed-system (excluding water sprinkler systems), including parts and attachments, manufacturing	0	\$0	\$0	NA	NA
<b>TOTAL*</b>			<b>89</b>	<b>\$11,843,000</b>	<b>\$14,485,000</b>	<b>NA</b>	<b>NA</b>

\*Total may not sum due to rounding.

**Table 17: Summary of the Small Business Impact at 3% Discount Rate**

Sector	NAICS Code	Industry	Estimated Number of Small Businesses Affected by the Rule	Total Annualized Economic Impact on Small Businesses		Annualized Compliance Cost as a Percentage of Total Annual Sales	
				Lower	Higher	Lower	Higher
Chillers	333415	Air-conditioning and warm air heating equipment and commercial and industrial refrigeration equipment manufacturing	1	\$2,880,000	\$3,260,000	0.7%	0.8%
	333415	Air-conditioning and warm air heating equipment and commercial and industrial refrigeration equipment manufacturing		\$3,030,000	\$3,790,000	0.7%	0.9%
Retail Food	333415	Air-conditioning and warm air heating equipment and commercial and industrial refrigeration equipment manufacturing	19	\$70,000	\$90,000	<0.1%	<0.1%
Household Refrigeration	335222	Household refrigerator and home freezer manufacturing	20	\$4,590,000	\$5,500,000	0.3%	0.3%
Cold Storage	333415	Air-conditioning and warm air heating equipment and commercial and industrial refrigeration equipment manufacturing	4	\$70,000	\$140,000	<0.1%-3.0%	<0.1%-6.2%
Foam	326150	Urethane and other foam product (except polystyrene) manufacturing	36	\$600,000	\$900,000	<0.1%-1.7%	<0.1%-2.6%
			8	\$300,000	\$400,000	0.2%-4.3%	0.2%-5.2%
			1	\$2,000	\$4,000	<0.1%-1.7%	<0.1%-2.6%
			0	\$0	\$0	NA	NA
Fire Suppression	339999 1	Fire extinguishing equipment, hand-portable and fixed-system (excluding water sprinkler systems), including parts and attachments, manufacturing	0	\$0	\$0	NA	NA
<b>TOTAL*</b>			<b>89</b>	<b>\$11,542,000</b>	<b>\$14,084,000</b>	<b>NA</b>	<b>NA</b>

\*Total may not sum due to rounding.

- Roughly 89 small businesses could be subject to the rulemaking, although roughly 76% of small businesses subject to this rulemaking would be expected to incur compliance costs that are estimated to be less than 1% of annual sales.
- This analysis indicates that up to 21 of the 89 affected small businesses—or roughly 24%—could incur costs in excess of 1% of annual sales, and that up to 12 small businesses could incur costs in excess of 3% of annual sales.
- Table aggregates the estimated economic impacts on small businesses, according to the categories set out in the SISNOSE decision matrix. For the most conservative assessment, Roughly 89 small businesses could be subject to the rulemaking, although roughly 76% of small businesses subject to this rulemaking would be expected to incur compliance costs that are estimated to be less than 1% of annual sales.
- This analysis indicates that up to 21 of the 89 affected small businesses—or roughly 24%—could incur costs in excess of 1% of annual sales, and that up to 12 small businesses could incur costs in excess of 3% of annual sales.

Table reflects the higher cost ranges for each end-use and a 7% discount rate. Using the decision criteria established in this screening analysis suggests that the regulatory changes can be presumed to have **no SISNOSE** for the following reasons:

- Roughly 89 small businesses could be subject to the rulemaking, although roughly 76% of small businesses subject to this rulemaking would be expected to incur compliance costs that are estimated to be less than 1% of annual sales.
- This analysis indicates that up to 21 of the 89 affected small businesses—or roughly 24%—could incur costs in excess of 1% of annual sales, and that up to 12 small businesses could incur costs in excess of 3% of annual sales.<sup>27</sup>

**Table 18: Aggregated Economic Impacts on Small Businesses**

Economic Impact	Industry Impacted		Number of Small Entities Subject to the Rule and Experiencing Given Economic Impact	Percent of All Small Entities Subject to the Rule That are Experiencing Given Economic Impact
Less than 1% for all affected small entities <sup>a</sup>	326150	Urethane and other foam product (except polystyrene) manufacturing	28	<b>76.4%</b>
	333415	Air-conditioning and warm air heating equipment and commercial and industrial refrigeration equipment manufacturing	20	
	335222	Household refrigerator and home freezer manufacturing	20	
	<b>Total</b>		<b>68</b>	
1% or more for one or more affected small entities <sup>b</sup>	326150	Urethane and other foam product (except polystyrene) manufacturing	17	<b>23.6%</b>
	333415	Air-Conditioning and Warm Air Heating Equipment and Commercial and Industrial Refrigeration Equipment Manufacturing	4	

<sup>27</sup> When the the firm size of the small businesses affected is not known, this analysis conservatively assumes that these businesses fall into the smallest facility size category (i.e., 0 to 4 employees) and, therefore, experience the high end of the range of economic impacts.

	<b>Total</b>		<b>21</b>	
Greater than 3% for one or more affected small entities	326150	Urethane and other foam product (except polystyrene) manufacturing	8	<b>13.5%</b>
	333415	Air-Conditioning and Warm Air Heating Equipment and Commercial and Industrial Refrigeration Equipment Manufacturing	4	
	<b>Total</b>		<b>12</b>	

<sup>a</sup> Represents small entities affected with an economic impact equal to or lesser than 1% but greater than 0%.

<sup>b</sup> This category aggregates the number of small entities that would be expected to experience an impact of 1% to 3% with the number of small entities that would be expected to experience an impact of 3% or greater.

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## Appendix A: Sensitivity Analysis of Amortization Period

In cases where capital costs are incurred to invest in new equipment as a result of the regulatory changes, the analysis assumes that these costs are annualized over the physical lifetime of the equipment. Since it is feasible that the financing period of these costs may vary, a sensitivity analysis was conducted to further assess the implications of this assumption. A summary of the regulatory changes that are impacted by this assumption are presented in Table 19 along with the assumed lifetime for annualizing costs and the resulting annualized compliance cost as a percentage of average annual sales per firm.

**Table 19: Regulatory Changes Impacted by Annualized Cost Assumptions**

End-Use	Lifetime for Annualizing Costs	Annualized Compliance Cost as a Percentage of Average Annual Sales per Firm*
Centrifugal Chillers	25 years	0.7%–0.8%
Household Refrigerators and Freezers	20 years	<0.1%–8.6%
Rigid PU: high-pressure two-component spray foam	25 years	<0.1%–3.9%
Rigid PU: low-pressure two-component spray foam	25 years	0.2%–7.8%
Rigid PU: one-component foam sealants	25 years	<0.1%–3.9%

\* Assumes a 7% discount rate.

Table 20 summarizes the change in annualized compliance costs as a percent of average annual sales per firm assuming a 10 year and 5 year lifetime for annualizing costs.

**Table 20: Annualized Compliance Costs Assuming a 30 Year and 10 Year Lifetime for Annualizing Costs**

NAICS Code	Industry Name	Annualized Compliance Cost as a Percentage of Average Annual Sales per Firm*	
		10 Year Lifetime	5 Year Lifetime
333415	Air-conditioning and warm air heating equipment and commercial and industrial refrigeration equipment manufacturing	0.7%–0.8%	0.7%–0.8%
335222	Household refrigerator and home freezer manufacturing	<0.1%–13.0%	<0.1%–22.2%
326150	Urethane and other foam product (except polystyrene) manufacturing	0.1%–6.4%	0.3%–11.0%
		0.4%–12.9%	0.6%–22.1%
		0.1%–6.4%	0.3%–11.0%

\* Assumes a 7% discount rate.

A comparison of the total annualized economic impact on small businesses under each lifetime assumption at a 7% and 3% discount rate is presented in Table 21 and Table 22, respectively. The aggregated economic impact on small businesses based on the higher cost range for each end-use and a 7% discount rate under each lifetime assumption is presented in Table 23.

**Table 21: Summary of the Total Small Business Impact by Lifetime Assumption at a 7% Discount Rate**

NAICS Code	Total Annualized Economic Impact on Small Businesses					
	Current Lifetime Assumption		10 Year Lifetime		5 Year Lifetime	
	Lower	Higher	Lower	Higher	Lower	Higher
333415	\$2,880,000	\$3,260,000	\$2,880,000	\$3,270,000	\$2,880,000	\$3,270,000
333415	\$3,000,000	\$3,760,000	\$3,000,000	\$3,760,000	\$3,000,000	\$3,760,000
333415	\$70,000	\$90,000	\$70,000	\$90,000	\$70,000	\$90,000
335222	\$4,590,000	\$5,500,000	\$4,590,000	\$5,500,000	\$4,590,000	\$5,500,000
333415	\$70,000	\$140,000	\$70,000	\$140,000	\$70,000	\$140,000
326150	\$800,000	\$1,200,000	\$1,330,000	\$1,990,000	\$2,270,000	\$3,410,000
	\$400,000	\$500,000	\$700,000	\$900,000	\$1,220,000	\$1,460,000
	\$3,000	\$5,000	\$6,000	\$8,000	\$10,000	\$14,000
	\$0	\$0	\$0	\$0	\$0	\$0
3399991	\$0	\$0	\$0	\$0	\$0	\$0
<b>TOTAL</b>	<b>\$11,843,000</b>	<b>\$14,485,000</b>	<b>\$12,646,000</b>	<b>\$15,658,000</b>	<b>\$14,110,000</b>	<b>\$17,644,000</b>

**Table 22: Summary of the Total Small Business Impact by Lifetime Assumption at a 3% Discount Rate**

NAICS Code	Total Annualized Economic Impact on Small Businesses					
	Current Lifetime Assumption		10 Year Lifetime		5 Year Lifetime	
	Lower	Higher	Lower	Higher	Lower	Higher
333415	\$2,880,000	\$3,260,000	\$2,880,000	\$3,270,000	\$2,880,000	\$3,270,000
333415	\$3,000,000	\$3,760,000	\$3,000,000	\$3,760,000	\$3,000,000	\$3,760,000
333415	\$70,000	\$90,000	\$70,000	\$90,000	\$70,000	\$90,000
335222	\$4,590,000	\$5,500,000	\$4,590,000	\$5,500,000	\$4,590,000	\$5,500,000
333415	\$70,000	\$140,000	\$70,000	\$140,000	\$70,000	\$140,000
326150	\$600,000	\$900,000	\$1,100,000	\$1,700,000	\$2,080,000	\$3,110,000
	\$300,000	\$400,000	\$600,000	\$700,000	\$1,110,000	\$1,330,000
	\$2,000	\$4,000	\$5,000	\$7,000	\$9,000	\$13,000
	\$0	\$0	\$0	\$0	\$0	\$0
	\$0	\$0	\$0	\$0	\$0	\$0
	\$0	\$0	\$0	\$0	\$0	\$0
3399991	\$0	\$0	\$0	\$0	\$0	\$0
<b>TOTAL</b>	<b>\$11,542,000</b>	<b>\$14,084,000</b>	<b>\$12,315,000</b>	<b>\$15,167,000</b>	<b>\$13,809,000</b>	<b>\$17,213,000</b>

**Table 23: Aggregated Economic Impacts on Small Businesses**

Economic Impact	Industry Impacted	Number of Small Entities Subject to the Rule and Experiencing Given Economic Impact			Percent of All Small Entities Subject to the Rule That are Experiencing Given Economic Impact		
		Current Lifetime Assumption	10 Year Lifetime	5 Year Lifetime	Current Lifetime Assumption	10 Year Lifetime	5 Year Lifetime
Less than 1% for all affected small entities <sup>a</sup>	326150	28	20	20	76.4%	67.4%	67.4%
	333415	20	20	20			
	335222	20	20	20			
	<b>Total</b>	<b>68</b>	<b>60</b>	<b>60</b>			
1% or more for one or more affected small entities <sup>b</sup>	326150	17	25	25	23.6%	32.6%	32.6%
	333415	4	4	4			
	<b>Total</b>	<b>21</b>	<b>29</b>	<b>29</b>			
Greater than 3% for one or more affected small entities	326150	8	11	17	13.5%	16.9%	23.6%
	333415	4	4	4			
	<b>Total</b>	<b>12</b>	<b>15</b>	<b>21</b>			

<sup>a</sup> Represents small entities affected with an economic impact equal to or lesser than 1% but greater than 0%.

<sup>b</sup> This category aggregates the number of small entities that would be expected to experience an impact of 1% to 3% with the number of small entities that would be expected to experience an impact of 3% or greater.