Draft Regulatory Impact Analysis Addendum:

Analysis of the Economic Impact and Benefits of the Proposed Rule: American Innovation and Manufacturing (AIM) Act Subsection H Management of Regulated Substances

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Table of Contents

Executive Summary 9

Climate Benefits 10

Compliance Costs 10

Net Benefits 10

Relationship to Allocation Framework Rule and 2024 Allocation Rule RIA Results 11

1. Introduction 13

1.1. Proposed Regulatory Requirements 14

1.2. Organization of this Document 16

2. Equipment Characterization 19

2.1. Equipment in the Fire Suppression Sector 19

2.2. Refrigeration and Comfort Cooling Appliances 19

2.3. Affected Equipment 21

3. Methodology 23

3.1. Relationship to Prior Analyses and Approach for Estimating Incremental Impacts 23

3.2. Costs and Benefits for Leak Repair and Inspection Provisions 26

3.3. Costs and Benefits for Reclamation Provisions 38

3.4. Costs and Benefits Related to Alternative Standards for Reclamation 38

3.5. Costs and Benefits for Handling of Disposable Cylinders and Container Tracking 39

3.6. Costs and Benefits for Reducing Emissions in the Fire Suppression Sector 40

3.7. Reporting and Recordkeeping Costs 40

3.8. Monetization of Emissions Benefits 44

3.9. Other Potential Benefits of this Rule 47

3.10. Costs and Benefits under a Marginal Abatement Cost Methodology 48

4. Economic Impact Analysis of Leak Repair and Inspection provisions 49

4.1. Annual Leak Repair Compliance Costs 49

4.2. Refrigerant Costs and Savings in 2025 by Rule Component 51

4.3. Leak Repair and Inspection Emission Reduction Benefits 53

4.4. Leak Repair and Inspection Emission Reduction Benefits in Later Years 53

4.5. Estimated Climate Benefits of Leak Repair 54

4.6. Comparison of Net Benefits for Alternative Leak Repair and Automatic Leak Detection Scenarios 55

5. Comparison of Costs and Benefits for the Proposed Rule 57

5.1. Comparison of Costs and Benefits of Leak Repair and Inspection Provisions 57

5.2 Comparison of Costs and Benefits of Required Use of Reclaimed HFCs 58

5.3 Comparison of Costs and Benefits of Requirements on HFC Cylinders 59

5.4 Comparison of Costs and Benefits of Fire Suppression Sector Provisions 59

5.5 Comparison of Costs and Benefits of RCRA Amendments 59

5.6 Recordkeeping and Reporting Costs 60

5.7 Comparison of Costs and Benefits of the Proposed Rule 61

6 Environmental Justice 63

6.1 Introduction and Background 63

6.2 Environmental Justice at EPA 63

6.3 Environmental Justice Analysis for this Rule 65

6.4 Aggregate Average Characteristics of Communities Near Potentially Affected Production Facilities 67

6.5 Previous Violation and Enforcement Actions 69

6.6 Conclusion 72

References 74

Appendices: 76

List of Tables

Table ES-1. Summary of Annual Values, Present Values, and Equivalent Annualized Values select years for the 2025–2050 Timeframe for Estimated Compliance Costs, Benefits, and Net Benefits for this Rule 11
Table 1-1 Proposed Leak Rate Thresholds by Equipment Category 16
Table 2-1. Estimated Installed Stock (MT) and Leak Emissions (MT) by Equipment Type (2025) 21
Table 2-2: Affected Appliance Assumptions by Equipment Sector, Type, and Size 23
Table 3-1: Leak Repair Outcomes and Proportions 27
Table 3-2: Leak Rate Assumptions by Equipment Sector, Type, and Size 28
Table 3-3: Unit Cost Assumptions for ALD Systems 31
Table 3-4: Unit Cost Assumptions for Leak Repair[a,b,c] 32
Table 3-5: Average 2025 GWP Assumptions by Equipment Type, Size, and Refrigerant Type 34
Table 3-6: Expected Emissions Reductions in 2025 by Equipment Type and Size 35
Table 3-7: Average GWP Assumptions by Equipment Type, Size, and Refrigerant Type for 2030, 2040, and 2050 37
Table 3-8: Expected Emissions Reductions by Equipment Type, Size, and Refrigerant Type for 2030, 2040, and 2050 37
Table 3-9: Labor Rates 41
Table 4-1: Aggregate Compliance Costs by Sector, Equipment Type, and Size[a] 49
Table 4-2. Incremental Annual Compliance Costs, Including Refrigerant Savings (2022$) 50
Table 4-3. Total Annual Refrigerant Savings in 2025 (2022$) and Combined Annual Cost and Annual Savings with 7% and 3% Discount Rate 51
Table 4-4. 2025 Incremental Compliance Costs for Recordkeeping and Reporting for Leak Inspection and Leak Repair (2022$) 52
Table 4-5. Annual GHG Emissions Avoided in 2025, 2030, 2040, and 2050 53
Table 4-6. Annual GHG Emissions Avoided in Select Years 54
Table 4-7. Monetized Climate Benefits (2022$) 54
Table 4-8. Comparison of Net Benefits for Alternative Leak Repair Thresholds. (Millions 2022$) 55
Table 4-9. Comparison of Net Benefits for Alternative ALD Thresholds (Millions of 2022$) 56
Table 5-1. Monetized Climate Benefits, Costs, and Net Benefits for Leak-related Provisions 57
Table 5-2. Monetized Climate Benefits, Costs, and Net Benefits for Required Use of Reclaim (millions of 2022$) 58

Table 5-3. Monetized Climate Benefits, Costs, and Net Benefits for Fire Suppression Sector Provisions Under High Additionality Scenario (millions of 2022$) 59
Table 5-4: Estimated Recordkeeping and Reporting Costs by Rule Provision (millions 2022$) .. 60
Table 5-5: Present Value and Equivalent Annual Value of the Net Benefits or Costs of Rule Provisions 2025–2050[a,b] 61
Table 6-1: Overall Community Profile and 2019 AirToxScreen Risks for Communities Near Identified Facilities 68
Table 6-2: Number of facilities falling under one or more environmental compliance regime 70
Table 6-3: Clean Water Act Compliance Status and Recent Enforcement History by Facility 70
Table 6-4: Resource Recovery and Conservation Act (RCRA) Compliance Status and Recent Enforcement History by Facility 71
Table 6-5: Clean Air Act (CAA) Compliance Status and Recent Enforcement History by Facility 72
Table A-1: Leak Rate Distributions for Equipment 77
Table A-2: Leak Rate Distributions for Equipment between 5 and 15 pounds 79
Table B-1: Initial Charge and Service Demand of HFCs for Applicable Subsectors in 2028 and 2029 80
Table B-2. Initial Charge Demand of HFCs for Applicable Subsectors in 2028 81
Table B-3: Service Demand of HFCs for Applicable Subsectors in 2028 82
Table B-4: Initial Charge Demand of HFCs for Applicable Subsectors in 2029 82
Table B-5: Service Demand of HFCs for Applicable Subsectors in 2029 83
Table B-6: Costs of Virgin Production, Destruction, and Reclamation ($/kg of refrigerant)[a] 84
Table B-7: GHG Emission Reductions Associated with Virgin Production, Destruction, and Reclamation (kgCO2eq/kg of produced refrigerant)[a] 85
Table B-8: Incremental Annual Cost Savings and GHG Emission Reductions Associated with Reclamation (Thousands 2022$) 85
Table E-1: Total Annual Refrigerant Savings in 2030 (2022$) and Combined Annual Cost and Annual Savings with 7% and 3% Discount Rate by Equipment Type 93
Table E-2: Total Annual Refrigerant Savings in 2040 (2022$) and Combined Annual Cost and Annual Savings with 7% and 3% Discount Rate by Equipment Type 95
Table E-3: Total Annual Refrigerant Savings in 2050 (2022$) and Combined Annual Cost and Annual Savings with 7% and 3% Discount Rate by Equipment Type 97
Table F-1: 2025 Total Annual Refrigerant Savings (2022$) and Combined Annual Cost and Annual Savings with 7% and 3% Discount Rate and Benefits for Equipment 5-50 pounds 100
Table F-2: 2025 Monetized Climate Benefits and Net Benefits with 7% and 3% Discount Rate for Equipment 5-50 pounds 102

Table F-3: 2035 Total Annual Refrigerant Savings (2022$) and Combined Annual Cost and Annual Savings with 7% and 3% Discount Rate and Benefits for Equipment 5-50 pounds 102
Table F-4: Annual GHG Emissions Avoided in 2030, 2040, and 2050 for Equipment 5–50 pounds 104
Table G-1: Unit Cost Assumptions for ALD Equipment for 500-pound Threshold 105
Table G-2: Aggregate Compliance Costs by Sector, Equipment Type, and Size for 500-pound ALD Threshold[a] 106
Table G-3: Incremental Annual Compliance Costs (2022$) for 500-pound ALD Threshold Scenario ... 107
Table G-4: Total Annual Refrigerant Savings in 2025 (2022$) and Combined Annual Cost and Annual Savings with 7% and 3% Discount Rate for 500-pound ALD Threshold Scenario 108
Table G-5: 2025 Incremental Compliance Costs for Recordkeeping and Reporting (2022$) for 500-pound ALD Threshold Scenario 109
Table G-6: Annual GHG Emissions Avoided in 2025, 2030, 2040, and 2050 for 500-pound ALD Threshold Scenario 111
Table G-7: Annual GHG Emissions Avoided in Select Years for 500-pound ALD Threshold Scenario 111
Table H-1: Average Number of Systems per Facility in Industries Containing Appliances with 15 or More Pounds of HFC Refrigerant 114
Table H-2: List of Industries Potentially Affected by the Prohibition of Disposable Cylinders by NAICS Code 117
Table H-3: Travel Distances for Disposable and Refillable Cylinders Before Disposal 119
Table H-4: Additional Transportation Assumptions 120
Table H-5: Transportation Assumptions before Disposal per Cylinder 121
Table H-6: Cost Assumptions for BAU and Rulemaking from Cylinder Heel Recovery Requirement... 122
Table H-7: Summary of Annual Economic Impacts from Cylinder Heel Recovery Requirement on Small Businesses by NAICS Code 123
Table H-8: School District and City Government Population and Revenue by Enrollment and Population Size 126
Table H-9: Leak Repair Outcomes per School District or City 127
Table H-10: Number of School Districts and Cities Affected by Leak Repair Scenarios 128
Table H-11: Decision Matrix for Certifying SISNOSE 129
Table H-12: Summary of the Small Entities Impact 129
Table H-13: Aggregated Economic Impacts on Small Entities with 7% Discount Rate 131
Table H-14: Aggregated Economic Impacts on Small Entities with 3% Discount Rate 134
Table I-1: NAICS Codes Included in the Leak Repair Analysis 138
Table J-1: SC-HFC-32 (2020$) 151

Table J-2: SC-HFC-125 (2020$) 152
Table J-3: SC-HFC-134a (2020$) 153
Table J-4: SC-HFC-143a (2020$) 154
Table J-5: SC-HFC-152a (2020$) 155
Table J-6: SC-HFC-227ea (2020$) 155
Table J-7: SC-HFC-236fa (2020$) 156
Table J-8: SC-HFC-245fa (2020$) 158
Table J-9: SC-HFC-43-10mee (2020$) 159
Table J-10: SC-HFC-23 (2020$) 160
Table K-1: Summary of abatement strategies modeled and key factors evaluated to derive MAC estimates 165
Table K-2: Incremental Annual Compliance Costs of MAC Abatement Options (Billions 2022$) 167
Table K-3: Annual Consumption Reductions in Allocation Rule Reference Case and Supplementary Subsection (h) Compliance Scenarios 168
Table K-4: Annual Emissions Reductions in Allocation Rule Reference Case and Supplementary Subsection (h) Compliance Scenarios 169
Table K-5: Discounted Monetized Climate Benefits 2025–2050 (billions of 2020$)[a,b,c] 170
Table K-6: Summary of Annual Incremental Climate Benefits, Costs, and Net Benefits in Base Case and High Additionality Case Scenarios for the 2025–2050 Timeframe (millions of 2020$, discounted to 2022)[a,b,c,d] 172
Table K-7: Leak Repair abatement options added to MACC model for the subsection (h) Rule analysis 177
Table K-8: ALD abatement options added to MACC model for the subsection (h) Rule analysis 178
Table K-9: Baseline percentage of demand met by reclaim 179
Table K-10: Initial charge reclaim abatement options added to MACC model for the subsection (h) Rule analysis 181
Table K-11: Combined leak repair, ALD, and reclaim abatement options added to MACC model for the subsection (h) Rule analysis 182
Table K-12: Servicing reclaim abatement options added to MACC model for the subsection (h) Rule analysis 183
Table K-13: Servicing reclaim abatement options added to MACC model for the subsection (h) Rule analysis, cont. 184
Table K-14: Fire suppression abatement options added to MACC model for the subsection (h) Rule analysis 185

Table K-15: Summary of Mitigation Options Modeled 186

List of Acronyms

AC	Air conditioning
AIM Act	American Innovation and Manufacturing Act of 2020, codified at 42 U.S.C. § 7675
ALD	Automatic Leak Detection
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
CAA	Clean Air Act
CC	Comfort cooling
CO_2	Carbon dioxide
CR	Commercial refrigeration
EPA	Environmental Protection Agency
GHGs	Greenhouse gases
GWP	Global Warming Potential
HFCs	Hydrofluorocarbons
HFOs	Hydrofluoroolefins
IPR	Industrial process refrigeration
MACC	Marginal abatement cost curve
$MTCO_2eq$	Metric tons of CO_2 equivalent
ODS	Ozone-depleting substances
O&M	operations and maintenance
PV	Present value
RACHP	Refrigeration, AC, and heat pump
RCRA	Resource Conservation and Recovery Act
RIA	Regulatory Impact Analysis
RMP	Refrigerant Management Program
SBREFA	Small Business Regulatory Enforcement Fairness Act of 1996
SC-HFCs	Social cost of HFCs
UMRA	Unfunded Mandates Reform Act
U.S.	United States

Executive Summary

This Draft Regulatory Impact Analysis (RIA) addendum provides an assessment of the costs and benefits of the proposed rule implementing provisions under subsection (h) of the American Innovation and Manufacturing Act of 2020, codified at 42 U.S.C. § 7675 (AIM Act or the Act). Subsection (h) of the AIM Act, entitled "Management of regulated substances," directs the United States (U.S.) Environmental Protection Agency (EPA) to promulgate regulations to control, where appropriate, any practice, process, or activity regarding the servicing, repair, disposal, or installation of equipment that involves: a regulated substance (used interchangeably with "HFCs" in the proposed rulemaking and in this RIA addendum), a substitute for a regulated substance, the reclaiming of a regulated substance used as a refrigerant, or the reclaiming of a substitute for a regulated substance used as a refrigerant.

This rulemaking follows an already finalized rule issued separately under the AIM Act, *Phasedown of Hydrofluorocarbons: Establishing the Allowance Allocation and Trading Program Under the American Innovation and Manufacturing Act* (Allocation Framework Rule, 86 FR 55116, October 5, 2021), as well as a later rule for the same program, *Phasedown of Hydrofluorocarbons: Allowance Allocation Methodology for 2024 and Later Years* (88 FR 46836, July 20, 2023).[1] The analysis presented in the sections below provides estimated economic costs and environmental impacts of the provisions of the proposed subsection (h) rule. The analysis also provides a comparison of these costs and benefits with those assessed for the Allocation Framework Rules to provide the public with an understanding of any potential changes in economic and environmental impacts relative to existing regulations. Results and methods from these analyses are referenced throughout this document. As with the 2024 Allocation Rule analysis, this document is presented as an addendum to the original Allocation Framework RIA. In addition, for the purposes of identifying potential environmental justice issues, the analysis presents EPA's assessment of the characteristics of communities near facilities reclaiming HFCs that are expected to be affected by the rule. The information provided in the environmental justice section of this document is for informational purposes only; EPA is not relying on the information in this section as a record basis for the proposed action.

This analysis is intended to provide the public with information on the relevant costs and benefits of this proposed rule and to comply with executive orders. While significant, the estimated benefits detailed

[1] Throughout this document, we use "Allocation Framework RIA" and "2024 Allocation Rule RIA Addendum" to refer to the analyses of these rules. We use "Allocation Rules" and "Allocation Rules RIA" to refer to combined or cumulative effect of those two rules; i.e., the Allocation Framework RIA as updated by the 2024 Allocation Rule RIA Addendum.

in this document are considered incidental and secondary to the rule's statutory objective of maximizing reclamation and minimizing releases of certain hydrofluorocarbons (HFCs).

Climate Benefits

The incremental benefits of this rule derive from reducing damages from climate change induced by reduced emissions of greenhouse gases (GHGs), specifically HFCs. The reduction in HFC emissions would stem from provisions contained in the proposed rule aimed at maximizing reclamation and minimizing the release of HFCs. The benefits of avoided climate damages are monetized using previously established social cost of HFCs (SC-HFCs) estimates and are presented in Table ES-1. In our base case estimate of incremental climate benefits, the proposed rule's provisions are estimated to produce benefits of $9.8 billion from 2025–2050, in 2022 dollars and discounted to 2024 at 3 percent.

Compliance Costs

Incremental compliance costs stem from industry transitions required to comply with provisions contained in the proposed rule. These include leak repair and inspection costs as well as Automatic Leak Detection (ALD) system costs for owners and operators of affected equipment. Incremental costs also stem from recordkeeping and reporting requirements detailed in the proposed rule. Reducing HFC emissions due to fixing leaks earlier would also be anticipated to lead to savings for some system owner/operators, as less new refrigerant would need to be purchased to replace leaked refrigerant. The estimated combined net incremental compliance costs (costs less anticipated savings) stemming from the proposed rule are shown in Table ES-1 in 2022 dollars, discounted back to 2024 at both 3 percent and 7 percent.

Net Benefits

The net benefits of the proposed rule are estimated as the climate benefits minus the compliance costs in each year. Annual net benefits for select years over the 2025–2050 time period are presented in Table ES-1, along with the net present value of the incremental benefits and costs. Provisions contained in the proposed rule are estimated to have incremental net benefits of $6.1 billion in 2022 dollars from 2025 through 2050, discounted at 3 percent to 2022, equivalent to $353 million in incremental annual benefits 2025–2050. When a discount rate of 7 percent is used for the costs, the net present value of the incremental net benefits is estimated at $7.4 billion, equivalent to $349 million in incremental annual net benefits 2025–2050.

Table ES-1. Summary of Annual Values, Present Values, and Equivalent Annualized Values select years for the 2025–2050 Timeframe for Estimated Compliance Costs, Benefits, and Net Benefits for this Rule (millions of 2022$, discounted to 2024) – Base Case Scenario [a,b,c,d]

Year	Climate Benefits (3%)	Costs (annual)		Net Benefits (3% Benefits, 3% or 7% Costs)	
2025	$582	$279		$304	
2030	$613	$194		$419	
2035	$597	$199		$399	
2040	$550	$203		$347	
2045	$483	$206		$277	
2050	$497	$213		$284	
Discount rate	**3%**	**3%**	**7%**	**3%**	**7%**
Present value	$9,822	$3,702	$2,395	$6,120	$7,427
Equivalent annualized value	$566	$213	$217	$353	$349

[a] Benefits include only those related to climate. Climate benefits are based on changes (reductions) in HFC emissions and are calculated using four different estimates of the social cost of HFCs (SC-HFCs): model average at 2.5 percent, 3 percent, and 5 percent discount rates; 95th percentile at 3 percent discount rate. For the presentational purposes of this table, we show the benefits associated with the average SC-HFC at a 3 percent discount rate, but the Agency does not have a single central SC-HFC point estimate. We emphasize the importance and value of considering the benefits calculated using all four SC-HFC estimates. As discussed in Chapter 4, a consideration of climate benefits calculated using discount rates below 3 percent, including 2 percent and lower, is also warranted when discounting intergenerational impacts. The costs presented in this table are annual estimates.
[b] Rows may not appear to add correctly due to rounding.
[c] The annualized present value of costs and benefits are calculated as if they occur over a 26-year period from 2025 to 2050.
[d] The present value (PV) for the 7% net benefits column is found by taking the difference between the PV of climate benefits at 3 percent and the PV of costs discounted at 7 percent. Due to the intergenerational nature of climate impacts the social rate of return to capital, estimated to be 7 percent in OMB's Circular A-4, is not appropriate for use in calculating PV of climate benefits.

Relationship to Allocation Framework Rule and 2024 Allocation Rule RIA Results

EPA has previously estimated costs and benefits of the HFC phasedown, which are detailed in the Allocation Framework RIA and 2024 Allocation Rule RIA Addendum. The proposed Subsection (h) Rule focuses on statutory provisions under the AIM Act that are separate from those addressed in the Allocation Framework Rule. However, in order to avoid double counting or overestimating of costs and benefits of the proposed action, for the purposes of this analysis the Allocation Framework Rule and 2024 Allocation Rule RIA Addendum are assumed to be the status quo from which incremental benefits may be calculated.

As detailed in the Allocation Framework Rule RIA and 2024 Allocation Rule RIA Addendum, EPA relied upon a Marginal abatement cost curve approach in order to estimate the full set of HFC abatement options and associated compliance costs required to meet the statutory phasedown caps from 2022–2050. Results from the analysis conducted for the proposed subsection (h) rule contained in this RIA Addendum indicate that the proposed rule will yield incremental HFC emissions reductions relative to this previously modeled set of transitions.[2] However, the estimated avoided emissions from some of the provisions contained in this proposed rule are less than what they would be if a reference scenario were used that does not assume these transitions and improved service activities occur. This is because some of the HFC consumption- and emissions-reducing activities required by the proposed rule (such as improvements to leak repair) were previously modeled for the Allocation Rules analyses and are therefore included in the reference case for this analysis.

While the proposed subsection (h) rule yields incremental benefits relative to EPA's prior estimates, some of these incremental benefits could be offset to the extent that additional HFC consumption allowances are "freed up," allowing for increased HFC consumption in equipment not covered by this rule, so long as overall domestic consumption and production remains within the AIM Act HFC phasedown cap for a given year. For example, if additional reclaimed HFCs are utilized in the commercial refrigeration subsector, industry may still shift the use of available consumption and production allowances to import or produce HFCs to meet demand for other sectors or subsectors that are not covered by a reclaim requirement.

To account for this uncertainty, this analysis provides two scenarios to illustrate the range of potential incremental impacts. In our base case scenario, we conservatively estimate that abatement from provisions in this rule may be offset by additional HFC consumption in subsectors not covered by this rule, even if these subsectors were previously assumed to have consumption abatement in the Allocation Rule Reference Case. To illustrate the potential upper bound incremental benefits of the proposed rule, we then provide a "high additionality" case, in which abatement in these additional subsectors is included. While this executive summary includes results from the base case only, results from both scenarios are provided in Chapter 4 of this RIA addendum.

These assumptions are made for technical analytic purposes only and to avoid double counting of benefits. They should not be interpreted as a reflection of the merits of any particular provision contained in the proposed rule. EPA may also revisit these assumptions before finalization of this rule or at a future date based on new information or public comment.

[2] However, the schedule for the production and consumption phasedown is not made more stringent than the schedule under subsection (e)(2)(C) of the AIM Act (i.e., the production and consumption caps contained in the Allocation Rules are unchanged).

1. Introduction

Under the American Innovation and Manufacturing Act (AIM Act), the United States (U.S.) Environmental Protection Agency (EPA) is directed under subsection (h), "Management of Regulated Substances," to promulgate certain regulations for purposes that include maximizing reclamation and minimizing releases of certain hydrofluorocarbons (HFCs). Subsection (h)(1) of the AIM Act authorizes EPA to establish regulations to control, where appropriate, practices, processes, or activities regarding the servicing, repair, disposal, or installation of equipment, for purposes of maximizing the reclamation and minimizing the release of certain HFCs from equipment and ensuring the safety of technicians and consumers.

Among other things, subsection (h) also provides for the Agency to consider options to increase opportunities for reclaiming HFCs used as refrigerants and potential approaches to coordinate regulations carrying out subsection (h) of the AIM Act with similar EPA regulations. Those regulations could, for example, include those implementing the refrigerant management program established under Title VI of the Clean Air Act (CAA).

Pursuant to subsection (h) of the AIM Act, EPA is proposing to require the repair of leaks in refrigerant-containing appliances with a charge size of 15 pounds or more of a refrigerant that contains an HFC or substitute for an HFC with a Global Warming Potential (GWP) greater than 53[3,4] (whether the appliance uses the HFC or substitute for an HFC neat or in a blend with other substances);[5] the use of automatic leak detection (ALD) systems for certain refrigeration equipment containing 1,500 pounds or more of a refrigerant containing an HFC or a substitute for an HFC with a GWP above 53 for both new and existing appliances; use of reclaimed refrigerant to fill new equipment and servicing or repairing existing equipment in certain refrigeration, air conditioning (AC), and heat pump (RACHP) subsectors; requirements regarding the servicing, repair, disposal, or installation of fire suppression equipment that contains HFCs, as well as requirements related to technician training in the fire suppression sector; and that used single-use ("disposable") cylinders that contain HFCs that have been used for the servicing, repair, or installation of certain refrigerant-containing equipment or fire suppression equipment be transported to an EPA-certified reclaimer or fire suppressant recycler, who would be required to remove

[3] In this document, EPA is using the term "HFC" to refer to the 18 HFCs listed as regulated substances in the AIM Act and codified in Appendix A to 40 CFR Part 84, and their isomers, whether the HFC is used neat or in a blend containing one or more of these HFCs. We are using the term "substitute" to refer to substitutes for HFCs with a GWP greater than 53, whether the substitute is used neat or in a blend.
[4] 53 is the lowest exchange value assigned to a listed HFC under Appendix A to 40 CFR Part 84 and is numerically equal to the 100-year integrated GWP of HFC-152 as listed in the IPCC Fourth Assessment Report (Forster et al. 2007).
[5] Throughout this document, for ease of reference we may refer to this as the 15-pound threshold, a charge size of 15 pounds or greater, or simply 15 pounds of refrigerant, without necessarily repeating that this includes refrigerants that contain an HFC or a substitute for an HFC with a GWP greater than 53.

the remaining HFCs, including the heel, prior to the disposal of these cylinders; labeling and tracking for disposable and refillable containers of HFCs that could be used for the servicing, repair, and/or installation of refrigerant-containing equipment or fire suppression equipment; and other recordkeeping and reporting requirements. In addition, EPA is proposing alternative Resource Conservation and Recovery Act (RCRA) standards for spent ignitable refrigerants being recycled for reuse.

The purpose of this Regulatory Impact Analysis (RIA), which builds on the RIA for Phasing Down Production and Consumption of HFCs (EPA 2021)[6] and the RIA for the AIM Act 2024 HFC Allocation Rule (EPA 2022a), is to provide the public with information on the relevant costs and benefits of this action, if finalized as proposed, and to comply with executive orders. This RIA documents the results of a costs and benefits assessment to help EPA and the public evaluate the impact of this proposed rulemaking across the affected businesses (see Appendix I). In addition to a cost and benefits analysis, EPA conducted an environmental justice analysis evaluating facilities and surrounding communities that may be impacted by this rule. Following the analytical approach used in the Allocation Framework Rule RIA, EPA has provided demographic data and the cancer and respiratory risks to surrounding communities. This update includes the most recent data available for the AirToxScreen dataset from 2020 (EPA 2023b).

1.1. Proposed Regulatory Requirements

The regulatory requirements proposed in this rulemaking include the following:

- Applying a suite of leak repair requirements to refrigerant-containing appliances, including comfort cooling (CC), commercial refrigeration (CR), and industrial process refrigeration (IPR) appliances, containing 15 or more pounds of a refrigerant containing a hydrofluorocarbon (HFCs) or a substitute for an HFC, excluding those that have a GWP of 53 and below (e.g., CO_2, ammonia, certain hydrofluoroolefins (HFOs)). This includes:
    - Requiring annual leak inspection for all CR and IPR appliances[7] containing 15 pounds up to 500 pounds of such refrigerant upon discovering the applicable leak rate is exceeded to identify the leak.
    - Requiring annual leak inspection for all CC and other appliances containing 15 pounds of such refrigerant upon discovering the applicable leak rate is exceeded to identify the leak.
    - Requiring quarterly leak inspection for all CR and IPR appliances that contain 500 pounds or more of such refrigerant upon discovering the applicable leak rate is

[6] Also referred to as the Allocation Framework Rule RIA in this document.

[7] EPA is proposing to exempt from the suite of leak repair requirements under subsection (h) any refrigerant-containing appliance used for the residential and light commercial air conditioning and heat pumps subsector.

exceeded (unless ALD equipment meeting certain requirements is used for compliance).

  - Requiring repair of leaks and initial and follow-up verification tests on the repairs for all appliances containing 15 or more pounds of such refrigerant (i.e., CC, CR, and IPR) when the applicable leak rate is exceeded.
  - Allowing owners/operators of all CC, CR, and IPR appliances containing 15 or more pounds of such refrigerant to request extensions to the leak repair and retrofit timeline.
  - Applying recordkeeping and reporting requirements associated with leak inspection and leak repair to appliances containing 15 pounds or more of such refrigerant.
- Use of ALD systems for CR and IPR appliances containing 1,500 pounds or more of a refrigerant containing an HFC or substitute for an HFC with a GWP above 53 for both new and existing appliances.
- Use of reclaimed refrigerant for new equipment and/or servicing/repair of specific RACHP appliances, including residential and light commercial AC, cold storage warehouses, industrial process refrigeration, stand-alone retail food refrigeration, supermarket systems, refrigerated transport, and automatic commercial ice makers.
- Requirements for the servicing, repair, disposal, or installation of fire suppression equipment that contains HFCs, as well as requirements related to technician training in the fire suppression sector.
- Requiring that disposable cylinders that have been used for the servicing, repair, or installation of refrigerant-containing equipment or fire suppression equipment be transported to an EPA-certified reclaimer or fire suppressant recycler; and that reclaimers and fire suppressant recyclers remove all HFCs from disposable cylinders prior to disposal.
- Use of a machine-readable tracking identifier for all containers of HFCs that could be used for the servicing, repair, or installation of refrigerant-containing equipment or fire suppression equipment and registration in the tracking system to update container tracking information.
- Finally, EPA is proposing alternative RCRA standards for spent ignitable refrigerants when recycled for reuse, as the term is proposed to be used under RCRA. EPA is proposing that the 40 CFR part 266 Subpart Q RCRA alternative standards would apply to HFCs and their substitutes that do not belong to flammability Class 3 as classified in the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Standard 34–2022.

Table 1-1 Proposed Leak Rate Thresholds by Equipment Category

Equipment Type	***Leak Rate Threshold***
Comfort Cooling	10%
Commercial Refrigeration	20%
Industrial Process Refrigeration	30%

1.2. Organization of this Document

The analysis contained in this document is organized as follows:

Chapter 2 summarizes the types of equipment affected by this rule. This includes equipment that relies on HFCs in the fire suppression, commercial refrigeration, industrial process refrigeration, and comfort cooling sectors. Using data from EPA's Vintaging Model, equipment is broken out by estimated average charge size (in pounds of refrigerant) and assumed leak rate. These data are used as a basis for estimating the scale of equipment affected by the leak repair and inspection provisions of this rule, as well as the costs and benefits of compliance.

Chapter 3 provides a synopsis of the methodologies relied upon to estimate the primary costs and benefits of this rule. Specific provisions analyzed include leak repair and inspection requirements, requirements to install ALD systems, and associated recordkeeping and reporting requirements. This chapter also summarizes the methodology for calculating the social cost of HFCs (SC-HFCs), also described in detail in Section 4.1 of the Allocation Framework RIA. The SC-HFC values are given in Appendix J.

Chapter 4 provides an assessment of the anticipated compliance costs and savings resulting from leak repair and inspection provisions contained in the proposed rule. This chapter also provides an analysis of the environmental benefits of these provisions. The reduction in emissions of these GHGs yields social benefits by reducing climate impacts. These climate benefits are monetized by multiplying the change in emissions of each regulated HFC by the SC-HFC value for that chemical.[8]

Chapter 5 provides a summary of anticipated costs and benefits for all provisions contained in the proposed rule, including proposed leak repair and inspection requirements, proposed requirements for the use of reclaimed HFCs, proposed cylinder management provisions, proposed fire suppression provisions, and proposed recordkeeping and reporting requirements. The estimated present value of net incremental benefits (benefits minus costs) is provided for all rule provisions.

[8] Although EPA is using SC-HFCs for purposes of some of the analysis in this document, the proposed action does not rely on those estimates of these costs as a record basis for the Agency action. EPA would reach the proposed conclusions even in the absence of the social costs of HFCs.

Chapter 6 covers the environmental justice analysis conducted for the rule. This analysis builds on the environmental justice analysis conducted for the Allocation Framework and Technology Transition[9] Rules and evaluates the demographic characteristics and baseline exposure of the communities near facilities that reclaim HFCs.

Appendix A provides details on leak rate assumptions derived from EPA's Vintaging Model and relied on in this analysis.

Appendices B, C, and D provide an evaluation of potential costs and benefits of a subset of the provisions contained in the proposed rule, including required use of reclaimed refrigerant for new equipment and servicing and/or repair of appliances in specific RACHP subsectors, the required use of recycled HFCs in fire suppression equipment, and the requirement that disposable cylinders that contain HFCs and that have been used in the service, repair or installation of refrigerant-containing or fire suppression equipment be sent to EPA-certified reclaimers or fire suppressant recyclers.

Appendix E provides a breakdown of estimated compliance costs and savings by affected appliance/equipment type related to proposed leak repair and inspection provisions.

Appendix F and G provide sensitivity analyses of costs and benefits under alternative policy scenarios considering a 5-pound threshold for annual leak repair and inspection of CC, CR, and IPR, rather than 15 pounds, and a 500-pound threshold for ALD systems. These supplementary analyses are provided for illustrative purposes.

Appendix H provides a Small Business Regulatory Enforcement Fairness Act (SBREFA) of 1996 analysis of estimated impact to small entities, including small businesses and small governments, associated with establishing the leak repair and inspection provisions and ALD requirements to HFC and substitutes for HFCs.

Appendix I lists the industries that might be affected by this rule.

Appendix J provides annual SC-HFC estimates used to estimate the climate benefits of this rule.

Appendix K analyzes certain restrictions in the proposed rule using an alternate methodology. Specifically, restrictions related to leak repair and leak inspection, required use of reclaimed refrigerant, and emission reductions in the fire suppression sector are analyzed using a marginal abatement cost

[9] Phasedown of Hydrofluorocarbons: Restrictions on the Use of Certain Hydrofluorocarbons Under Subsection (i) the American Innovation and Manufacturing Act of 2020 (AIM Act Technology Transitions Rule). (Docket No. EPA-HQ-OAR-2021-0643-0073

approach. This supplementary analysis builds on the approach taken in analyses conducted for the Allocation Framework Rule RIA and the 2024 Allocation Rule RIA Addendum.

Appendix L provides a statement prepared in accordance with section 202(a) of the Unfunded Mandates Reform Act (UMRA).

2. Equipment Characterization

2.1. Equipment in the Fire Suppression Sector

Fire suppression equipment covered by this rule fall into two categories, and both types of equipment may contain HFCs that would be discharged in the event of a fire. Total flooding systems are designed to automatically discharge a fire extinguishing agent by detection and related controls (or manually by a system operator) and achieve a specified minimum agent concentration throughout a confined space (i.e., volume percent of the agent in air) that is sufficient to suppress development of a fire. Streaming applications use portable fire extinguishers that can be manually manipulated to discharge an agent in a specific direction and release a specific quantity of extinguishing agent at the fire.

2.2. Refrigeration and Comfort Cooling Appliances

A variety of RACHP appliances used in the United States contain refrigerants, and these appliances can be organized into the following charge size groups: 1) appliances containing five or fewer pounds of a refrigerant containing an HFC or substitute for an HFC, 2) appliances containing between five and 15 pounds of such refrigerant, and 3) appliances containing more than 15 pounds of such refrigerant. For this analysis, affected equipment is considered to be refrigeration and AC appliances containing 15 pounds or more of a refrigerant containing an HFC or substitute for an HFCs.

Figure 2-1**Error! Reference source not found.** shows the projected installed stock of HFC refrigerant by RACHP appliance type across all equipment sizes in the United States in 2025, as modeled in EPA's Vintaging Model (EPA 2023a)[10] and Figure 2-2 shows annual leak emissions (exclusive of loss during disposal) by appliance type in 2025. These appliances contain approximately 1.0 million MT (2.2 billion pounds) of HFC refrigerant and are estimated to release approximately 82,000 MT (180 million pounds) of HFC refrigerant in 2025; an aggregate average leak rate of 8.2%. Table 2-1 summarizes stock and leak emissions in 2025 for each appliance type.

[10] As explained in the RIA to the Allocation Framework Rule and associated addenda to that RIA, the Vintaging Model estimates the consumption and emissions from subsectors that traditionally relied on ODS and are transitioning to HFCs and other alternatives. The EPA 2023 version of the model incorporates the transitions and practices anticipated to occur under the 2024 Allocation Rule. Other or different transitions as modeled under the Technology Transitions RIA addendum are not specifically included in this version of the Vintaging Model because at the time of this writing, EPA had not issued any final rule related to the Technology Transitions proposed rule.

Figure 2-1 – Projected Installed Stock (MT) of HFC Refrigerant by RACHP Appliance Type and Charge Size (2025)

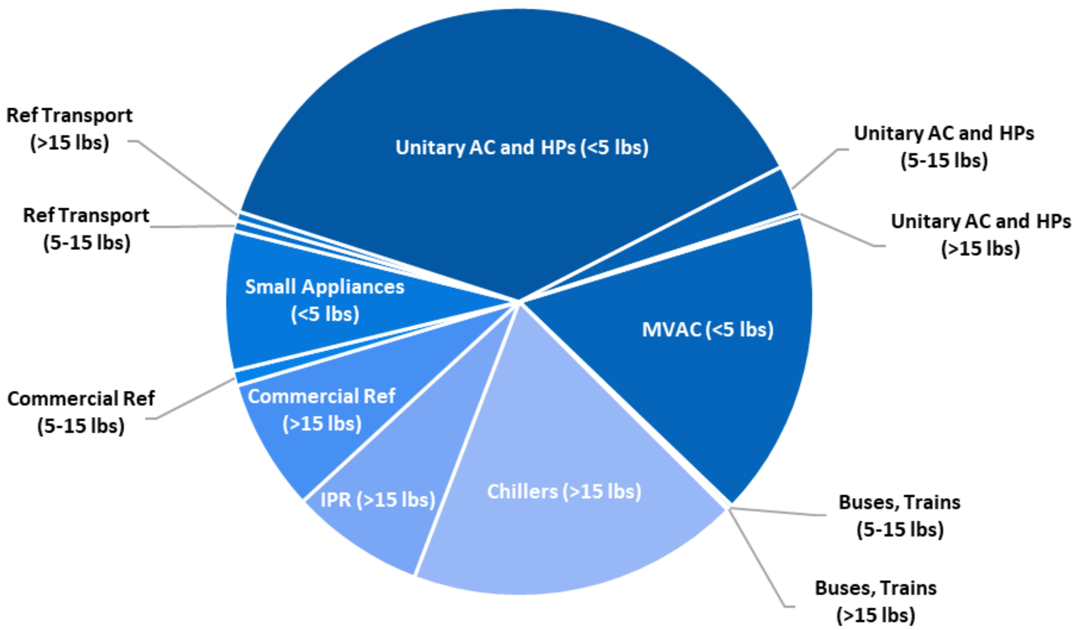

Figure 2-2 – Estimated leak Emissions (MT) of HFC Refrigerant by RACHP Appliance Type and Charge Size (2025)

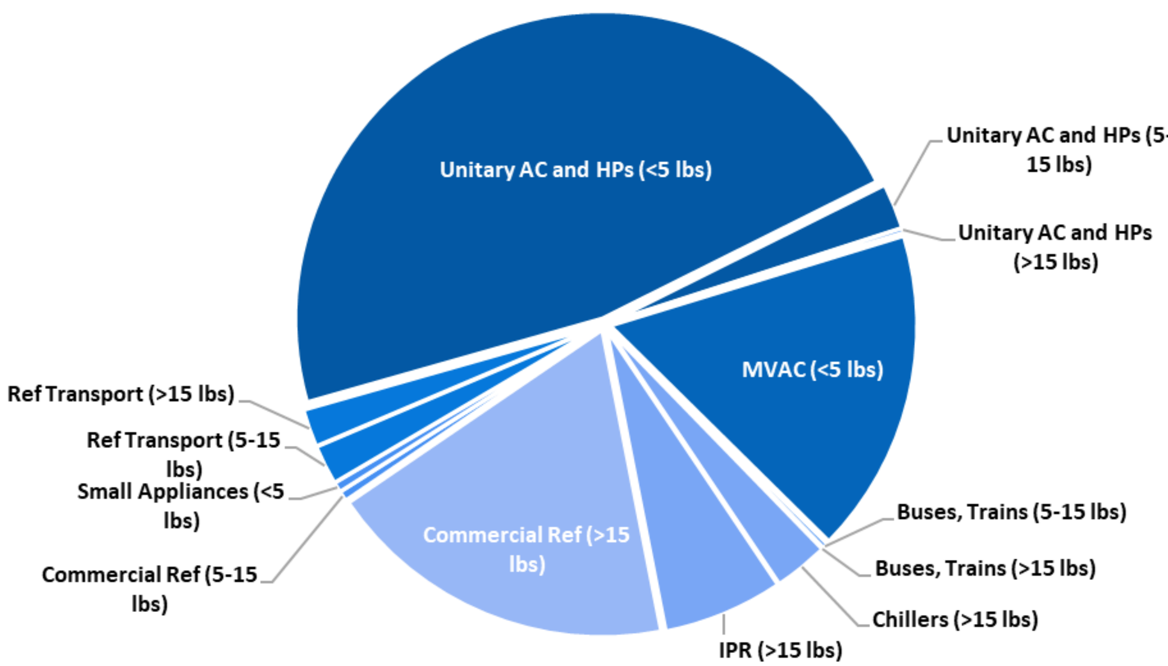

Table 2-1. Estimated Installed Stock (MT) and Leak Emissions (MT) by Equipment Type (2025)

Equipment Type	***Installed Stock (MT)***	***% of Total Installed Stock***	***Leak Emissions (MT)***	***% of Total Leak Emissions***
MVAC (<5 lbs)	165,600	17%	14,000	17%
Unitary AC and HPs (<5 lbs)	367,100	37%	38,400	47%
Small Appliances (<5 lbs)	75,100	8%	400	0.5%
<5 lbs total	**607,800**		**52,800**	
Buses, Trains (5-15 lbs)	2,400	0.2%	200	0.2%
Ref Transport (5-15 lbs)	5,600	1%	1,700	2%
Commercial Ref (5-15 lbs)	8,100	1%	400	0%
Unitary AC and HPs (5-15 lbs)	25,500	3%	2,000	2%
5-15 lbs total	**41,600**		**4,300**	
Buses, Trains (>15 lbs)	700	0.1%	50	0.1%
Chillers (>15 lbs)	179,400	18%	2,300	3%
IPR (>15 lbs)	72,000	7%	5,200	6%
Commercial Ref (>15 lbs)	71,100	7%	15,200	19%
Ref Transport (>15 lbs)	5,000	1%	1,600	2%
Unitary AC and HPs (>15 lbs)	2,500	0.3%	200	0.2%
>15 lbs Total	**330,700**		**24,600**	
Total	**980,100**		**81,700**	

2.3. Affected Equipment

CR, CC, and IPR equipment containing 15 pounds or more of HFC refrigerant[11] were identified using EPA's Vintaging Model. The appliance types within each sector include:

- **Commercial refrigeration** systems are the refrigeration appliances used in the retail food and cold storage warehouse sectors and refrigerated transport systems. Retail food appliances include the refrigeration equipment found in supermarkets, convenience stores, restaurants, and other food service establishments and include multiplex rack systems and condensing unit systems. Cold storage systems include the equipment used to store meat, produce, dairy products, and other perishable goods. Refrigerated transport systems include the equipment to move perishable goods (e.g., food) and pharmaceutical products by various modes of transportation, including rail and ships.

- **Industrial Process Refrigeration** systems are complex, customized systems used in the chemical, pharmaceutical, petrochemical, and manufacturing industries. These systems are

[11] Although the proposed rule also covers substitutes for an HFC, this analysis focuses on HFCs and HFC-containing blends, including HFC-containing substitutes, noting that most other HFC substitutes modeled have small to zero GWPs (e.g., hydrocarbons, hydrofluoroolefins, carbon dioxide, and ammonia).

directly linked to the industrial process. This sector also includes industrial ice machines, appliances used directly in the generation of electricity, and ice rinks.

- **Comfort Cooling** includes stationary refrigeration equipment that provides cooling in order to control heat and/or humidity in occupied facilities, such as office buildings and commercial buildings, and mobile AC equipment. Comfort cooling appliances include building chillers (which can be further broken down by compressor type) and mobile AC for transit, school, and tour buses and passenger trains.

Additional description of the Vintaging Model end-uses within each sector and equipment category is provided in Appendix A.

The Vintaging Model models equipment using average charge sizes. To provide additional variation in potential costs and benefits for larger equipment where a more significant range of possible charge sizes is likely (i.e., equipment containing more than 50 pounds of refrigerant), these end-uses were distributed into “small” (i.e., 50 percent of the modeled average charge size), “medium” (i.e., the modeled average charge size), and “large” (i.e., 150 percent of the modeled average charge size) groups. Each group was assigned one-third of the total units, and the charge size distributions equal the weighted average charge size modeled in the Vintaging Model. Each end-use was then categorized as sub-small (containing between 15 and 50 pounds of refrigerant), small (containing between 51 and 199 pounds of refrigerant), medium (containing between 200 and 1,999 pounds of refrigerant), and large (containing greater than 2,000 pounds of refrigerant).

Only RACHP appliances that experience leaks that exceed the annual leak threshold are subject to repair and inspection requirements and thus incur compliance costs to inspect the equipment and repair those leaks. The proportion of appliances above the leak rate thresholds for all equipment containing 15 pounds or more of refrigerant was based on equipment stock estimated in the Vintaging Model. Because the Vintaging Model models equipment using average leak rates,[12] equipment stock was distributed into quintiles, each containing 20 percent of units, where the leak rate distributions equal the weighted average leak rate modeled in the Vintaging Model for each equipment type. Based on this approach, it is assumed that each subsector has at least 20 percent of its stock (i.e., one quintile) above the threshold leak rate. See Appendix A for more detail.

[12] For chillers, large retail food (rack systems), cold storage, and industrial process refrigeration systems, the leak rate distributions were applied to the average leak rate modeled in the Vintaging Model as of 2025 with a 40 percent leak rate reduction, which is consistent with the assumption that larger refrigeration and AC equipment will experience enhanced leak recovery under the 2024 Allocation Rule as explained in the RIA to the Allocation Framework Rule and associated addenda to that RIA.

Table 2-2 presents the assumptions made for this analysis regarding the proportion of affected appliances experiencing leaks above the threshold.

Table 2-2: Affected Appliance Assumptions by Equipment Sector, Type, and Size

Appliance Sector	***Equipment Type***	***Equipment Size***	***Average Charge Size (lbs)***[a]	***Percentage of Appliances Experiencing Leaks Above the Threshold Rate***
Comfort Cooling	School & Tour Bus AC[b]	Sub-small	16	13%
	Transit Bus AC	Sub-small	16	40%
	Passenger Train AC	Sub-small	41	20%
	Chiller	Medium	265 – 1,985	20%
		Large	2,084 – 2,786	20%
Commercial Refrigeration	Modern Rail Transport[c]	Sub-small	17	80%
	Vintage Rail Transport[c]	Sub-small	33	80%
	Condensing Unit	Sub-small	47	20%
	Marine Transport	Small	194	80%
		Medium	388 – 1,653	80%
		Large	2,480	60%
	Rack	Medium	986–1,972	20%
		Large	2,959	20%
	Cold Storage	Large	10,655 – 38,147	20%
Industrial Process Refrigeration	IPR	Medium	1,049 – 1,059	20%
		Large	2,099 – 23,816	20%

[a] For some equipment types, the Vintaging Model models multiple subsectors which are distinguished by size, original ozone-depleting substances (ODS) refrigerant type, or technology. In those cases, a range is provided.
[b] 66 percent of School & Tour Bus AC units have charge sizes below the leak rate threshold of 15 lbs. and therefore are not included as affected appliances (EPA 2023a).
[c] The Vintaging Model models two subsectors for refrigerated rail car transport: vintage and modern. Modern rail refrigeration systems are considered to be easily replaceable units previously developed for road transport and adapted for rail use, have a lifetime of approximately 9 years, and a refrigerant charge size less than 20 pounds. Older or vintage units were typically developed specifically for rail use and operate for the whole lifetime of the railcar itself (i.e., 40 years) and have larger charge sizes than modern systems (EPA 2023a).

3. Methodology

3.1. Relationship to Prior Analyses and Approach for Estimating Incremental Impacts

EPA has previously estimated costs and benefits of the HFC phasedown, which are detailed in the Allocation Framework RIA and 2024 Allocation Rule RIA Addendum. The proposed Subsection (h) Rule focusses on statutory provisions under the AIM Act that are separate from those addressed in the Allocation Framework Rule. However, in order to avoid double counting or overestimating of costs and benefits of the proposed action, for the purposes of this analysis the Allocation Framework Rule and 2024 Allocation Rule RIA Addendum are assumed to be the status quo from which incremental benefits may be calculated.

This analysis does not consider the technology transitions that were included in the proposed Phasedown of Hydrofluorocarbons: Restrictions on the Use of Certain Hydrofluorocarbons Under Subsection (i) the American Innovation and Manufacturing Act of 2020 (AIM Act Technology Transitions Rule) RIA Addendum. (Docket No. EPA-HQ-OAR-2021-0643-0073, Appendices C & D) since, at the time of this writing, that rule has not been finalized.

As detailed in the Allocation Framework Rule RIA and 2024 Allocation Rule RIA Addendum, EPA relied upon a Marginal abatement cost curve (MACC) approach in order to estimate the full set of HFC abatement options and associated compliance costs required to meet the statutory phasedown caps from 2022–2050. Emissions benefits were then estimated based on the difference between HFC emissions in the compliance pathway and HFC emissions under a BAU scenario without the statutory phasedown caps in place. This previously modeled compliance path is referred to in this analysis as the "Allocation Rule Reference Case."

The Allocation Rule Reference Case impacts EPA's assumptions regarding the projected incremental impact of the proposed rule in the following ways:

1) Total HFC consumption and emissions over time for appliances across all major sectors (including fire suppression, CC, IPR, and CR) is significantly lower (in carbon dioxide equivalent (CO_2e) terms) than it otherwise would be under a BAU scenario. Since this analysis assumes these transitions and improved service activities occur in the reference case, the estimated avoided emissions from some of the provisions contained in this proposed rule are less than what they would be if a BAU scenario were used that does not assume these transitions and improved service activities occur.
2) EPA assumes that under the Allocation Framework Rule, one possible result of proposed provisions in this rule is that industry will maximize the use of allowances still available to meet remaining demand for HFC production and consumption in a given year. Therefore, certain provisions in this proposed rule (e.g., requiring the use of reclaimed HFCs for refrigerant-containing equipment for certain RACHP subsectors and recycled HFCs for fire suppression equipment) may not yield significant additional HFC consumption reductions,

relative to what was previously modeled in the Allocation Rule Reference Case. For example, if additional reclaimed HFCs are utilized in the commercial refrigeration subsector, industry may still shift the use of available consumption and production allowances to import or produce HFCs to meet demand for other sectors or subsectors that are not covered by a reclaim requirement.

To represent the possibility that the use of allowances might not be maximized, the costs and benefits of some proposed rule provisions are given as a range, with one end of the range being our "base case" scenario, where we assume that decreases in consumption of virgin HFCs in one sector or subsector is offset by an increase in consumption in some other sector or subsector, while the other end of the range is a "high additionality" estimate assuming that decreases in consumption are additional and offsetting allowance activity does not occur.

Despite the lower amounts of HFC consumption in the base case, as shown in chapter 4, the leak detection and repair provisions of this rule are still projected to yield significant benefits due to avoided emissions from the residual future demand for HFCs not phased out under the compliance path as well as the existing stock of equipment containing HFCs.

EPA notes that the above assumptions are made for technical analytic purposes only and to avoid double counting of benefits. They should not be interpreted as a reflection of the merits of any particular provision contained in the proposed rule. EPA may also revisit these assumptions before finalization of this rule or at a future date based on new information or public comment.

Moreover, there are likely significant benefits associated with provisions contained in the proposed rule that are not quantified in the incremental benefits presented in this document. These include, but are not limited to:

- the life-cycle cost savings associated with the use of reclaimed HFCs and substitutes for HFCs as opposed to virgin HFCs and substitutes for HFCs;
- the moderation of future spikes in the cost of HFCs due to increased availability of reclaimed HFCs;
- avoidance of stranded equipment in later years where if the market were reliant on virgin HFCs scarcity could result in shortages;
- ensure demand for the cold chain for food and vaccines is met; and
- the freeing up of available virgin HFCs for applications where reclaimed HFCs cannot be used (e.g., metered dose inhalers (MDIs) for treatment of asthma or Chronic Obstructive Pulmonary Disease (COPD)).

- Avoided supply shortages of HFCs that are still needed for servicing certain appliances, by maximizing the supply of reclaimed refrigerant, thus protecting the cold chain needed to deliver food and vaccines.

3.2. Costs and Benefits for Leak Repair and Inspection Provisions

The sections below describe the method and assumptions used to estimate aggregate incremental costs and benefits associated with the Agency's proposed regulations related to leak repair and inspection.

3.2.1 Approach for Estimating Costs

The proposed rule provisions associated with leak repair and inspection are expected to result in:

- **Incremental compliance costs** associated with conducting leak detection/inspections and repairs.
- **Refrigerant savings** associated with detecting and repairing leaks earlier.

Costs and savings were first estimated using a model equipment approach, and then were scaled up industry-wide based on the total number of affected equipment using EPA's Vintaging Model and the approach outlined in Section 2.3.

Leak Repair

The proposed regulation results in incremental compliance costs to owners and operators when leaks in appliances containing 15 or more pounds of refrigerant containing an HFC or a substitute for an HFC that has a GWP above 53 exceed the threshold leak rate. Owners and operators must repair leaks within 30 days, or, under certain circumstances, request an extension to conduct the repair. If leaks cannot be repaired, the appliance must be retrofitted or retired. These requirements are incremental for owners and operators of appliances containing 15 or more pounds of such refrigerant that exceeds the leak rate of 10 percent for CC, 20 percent for CR, or 30 percent for IPR equipment. When leaks are repaired, all appliances must also conduct initial and follow-up verification tests.

Leak repair outcomes. Extending leak rate thresholds to these refrigerant-containing appliances should result in leaks being identified and repaired sooner than previously assumed in the Allocation Rule Reference Case previously evaluated by EPA. This analysis assumes that leaks will be detected and repaired earlier across all CC, CR, and IPR appliances containing 15 pounds or more of HFC refrigerant. Specifically, the analysis assumed that HFC appliances that experience a leak event requiring repair realizes one of three outcomes:

- The **standard repair** outcome conservatively assumes that as a result of the leak rate threshold, repairs are conducted six weeks earlier than they would have been conducted when waiting for the system performance to noticeably change due to refrigerant loss. If the system is using ALD monitoring, repairs are assumed to be conducted ten weeks earlier.
- Under the **extension repair** outcome, owners/operators request an extension for conducting the repair. The analysis conservatively assumes that repairs are also conducted six weeks earlier as a result of the leak repair requirements (or ten weeks earlier if the system is using ALD monitoring). As mentioned above, the extension allows owners/operators additional time to repair an appliance if components cannot be delivered within the necessary time.
- The **retrofit** outcome assumes that systems that require retrofitting are retrofitted 5 years earlier than they would have been in the absence of the proposed regulations (i.e., five years were assumed to be remaining before normal end-of-life).

Table 3-1 Below shows the proportion of affected appliances assumed to experience each outcome.

Table 3-1: Leak Repair Outcomes and Proportions

Outcome	***HFC Systems***
Standard Repair	98%
Extension Repair	1%
Retrofit	1%

Frequency of repair. Data reported under California's Refrigerant Management Program (RMP) was reviewed to determine an appropriate assumption for the annual frequency of repair for systems that use ALD monitoring systems or are inspected annually or quarterly and are leaking above the threshold annual leak rates proposed in this action. These data suggest that most systems greater than 50 pounds are repaired once per year, with the exception of larger (>500 pounds) cold storage systems, which are repaired about twice per year on average (CARB 2009a).[13] This analysis assumes that there would be a similar relationship between appliances that are subject to this proposed rule (under subsection (h) of the AIM Act) as there is for the appliances subject to California's RMP.

Repair effectiveness and baseline leak rates. For all equipment types and sizes, post-repair leak rates reflect California Air Resources Board (CARB) (2009a) estimates, which were based on EPA's

[13] Cold storage systems that are repaired twice are assumed to follow a modified standard repair outcome. After the first leak is repaired, the system is assumed to leak for six weeks (without ALD) or 10 weeks (with ALD) at the post-repair leak rate. At that point, the system is assumed to experience a failure such that six weeks (without ALD) or 10 weeks (with ALD) after the original repair the system has leaked a qualifying amount of refrigerant to require a second repair.

Vintaging Model and Intergovernmental Panel on Climate Change (IPCC)/Technology and Economic Assessment Panel (TEAP) (2005) recommendations. The modeled leak rates represent an outcome in which a post-repair leak rate of zero is not achieved. This assumption therefore may be more conservative than what may be actually achieved once this rule is implemented (i.e., this may assume more post-repair leakage than actually occurs). This is because the GWP-weighted amount of emissions prevented by a given leak repair equals the number of weeks multiplied by the difference of the leak rate pre-repair and the leak rate post-repair) multiplied by the GWP of the refrigerant leaking. A higher post-repair leak rate results in a lower change in leak rate, which results in a lower estimate of emissions prevented. On the other hand, some owners and operators may choose to repair the leak to the point where the leak rate does not trigger further leak repair, in which case the assumed non-zero post-repair leak rate may be more reflective of actual industry behavior.

Table 3-2 below presents the final leak rate assumptions by equipment sector, type, and size for equipment that is affected by the proposed leak repair requirements (i.e., is expected to leak above the leak rate thresholds).[14] The percentage of each equipment type that is experiencing a qualifying leak was presented earlier in Table 2-2.

Table 3-2: Leak Rate Assumptions by Equipment Sector, Type, and Size

Leak Rate Threshold	***Appliance Sector***	***Equipment Type***	***Equipment Size***	***Baseline Annual Leak Rate (for Equipment Requiring Repair)***	***Annual Post-repair Leak Rate***
10%	CC	School & Tour Bus AC	Sub-small	13%	10%
		Transit Bus AC	Sub-small	14%	8%
		Passenger Train AC	Sub-small	10%	2%
		Chiller	Medium	10% – 11%	2%
			Large	10%	2%
20%	CR	Modern Rail Transport	Sub-small	37%	19%
		Vintage Rail Transport	Sub-small	42%	15%
		Condensing Unit	Sub-small	22%	15%
			Small	37%	10%

[14] The average baseline annual leak rates shown in Table 3-2 are based on actual leak rate data reported to the CARB RMP. For sub-small equipment, the annual post-repair leak rates are based on the average Vintaging Model leak rate (if lower than the leak rate threshold for the equipment type) or the quintile 1 or quintile 2 leak rate from the modeled leak rate distributions (see Appendix A for more information).

Leak Rate Threshold	Appliance Sector	Equipment Type	Equipment Size	Baseline Annual Leak Rate (for Equipment Requiring Repair)	Annual Post-repair Leak Rate
		Marine Transport	Medium	29% – 37%	10%
			Large	29%	10%
		Rack	Medium	22%	10%
			Large	22%	10%
		Cold Storage	Large	20% – 25%	10%
30%	IPR	IPR	Medium	30% – 34%	7%
			Large	30% – 34%	7%

Source: EPA (2023a)

Leak Inspection

The proposed regulations would result in incremental compliance costs to appliance owners and operators who would need to conduct leak inspections when leaks are identified that exceed the annual threshold leak rate (i.e., 10% for CC, 20% for CR, or 30% for IPR). For CR and IPR systems with charge sizes between 15 and 500 pounds and for CC and other appliances with charge sizes at or above 15 pounds, leak inspections are annual, and for CR and IPR systems with charge sizes between 500 and 1,500 pounds, leak inspections are quarterly. As a baseline, the cost analysis conservatively assumes that annual leak inspections are not currently performed. This assumption may overestimate compliance costs since, some owners and operators have indicated they conduct regular leak inspections to ensure that systems continue to function properly, to avoid recurring refrigerant top-off costs, or they are required to do so based on state regulations. Although the cost analysis assumes no annual leak inspections in the baseline, when estimating baseline emissions, the real-world prevalence of ALD in each subsector is empirically captured in the average leak rates in the Vintaging Model (i.e., unlike costs, emissions are not conservatively estimated, nor are they overestimated due to this assumption). For CR and IPR systems with charge sizes above 1,500 pounds, ALD monitoring is required, so no additional inspections are assumed for these appliances. The incorporation of ALD in the model partially ameliorates the overestimation of costs for leak inspection but does not account for all overestimation due to current leak inspection practices.

Unit Cost and Savings Assumptions

Leak inspection. Leak inspections were assumed to require, on average, four hours per system per inspection for CR and IPR appliances, and two hours for CC appliances.

An hourly labor rate of $55.21 was assumed for leak repair and inspection, based on the median hourly earnings of $26.29 for the Heating, Air-conditioning, and Refrigeration Mechanics and Installers occupational group (49-9021) from the Bureau of Labor Statistics (BLS 2022), plus 110 percent to account for overhead ($28.92). All costs in this report are reported in 2022 dollars, unless otherwise noted.

ALD systems. Direct and indirect ALD system costs include the capital expenditure to purchase the hardware (e.g., detector, sensors), plus installation costs and operations and maintenance (O&M) costs associated with annual system maintenance, certification, and data tracking/storage. These costs are assumed to vary by system size (e.g., number of zones and sensors) and are summarized in Table 3-3, with direct ALD systems requiring higher material and installation costs than indirect systems because a separate monitoring device and zone sensors are required (see Technical Support Document (TSD)[15] titled *American Innovation and Manufacturing Act of 2020 – Subsection (h): Automatic Leak Detection System*) for more information). For the purposes of this analysis, 50 percent of equipment owners were assumed to install direct ALD systems, which offer additional monitoring capabilities that automatically provide certain reporting and recordkeeping requirements, and 50 percent of equipment owners are assumed to install indirect ALD systems. In the first year of the proposed regulation, equipment owners of all CR and IPR appliances containing 1,500 pounds or more of refrigerant would be required to purchase and install an ALD system (assuming 10–21 percent of existing and new equipment would already have regularly calibrated ALD systems installed[16]), which is assumed to last the full lifetime of the equipment. In subsequent years, new equipment entering the market would also experience costs to purchase and install an ALD system. The upfront costs to purchase and install a direct ALD system were annualized over a 5-year period using a rate of 9.8 percent,[17] whereas indirect ALD system owners are not assumed to finance the material and installation costs. Owners and operators were also assumed to experience annual O&M costs throughout the life of the ALD system.

[15] Available in the docket (EPA-HQ-OAR-2022-0606) for this rulemaking at *https://www.regulations.gov*.
[16] This assumes that 10 percent of CR and IPR equipment under 1,500 lb would have ALD already installed or would be expected to install ALD in the absence of this rulemaking, 16 percent of appliances 1,500–2,000 lb, and that 21 percent of CR and IPR equipment have ALD as required in California (based on population of California relative to the United States) for appliances greater than 2,000 lb.
[17] Businesses are expected to treat ALD systems as capital assets and therefore it is assumed that businesses would be able to access financing for their purchase, if desired, for a loan tenure of five years. The discount rate used in this analysis is consistent with the RIA to the Allocation Framework Rule, which identified a weighted average cost of capital in this sector of 9.8 percent (EPA 2023a).

Table 3-3: Unit Cost Assumptions for ALD Systems

System Size	Material Cost	Labor Hours	Installation Cost	Equipment and Installation Cost	Annualized Equipment and Installation Cost (Years 1-5)	Annual O&M Cost
Direct ALD System						
1,500–2,000	$9,000	16	$883	$9,880	$2,594	$1,250
2,000+	$9,850	20	$1,104	$10,950	$2,875	$1,440
Indirect ALD System						
1,500-2,000	$2,850	8	$440	$3,290	NA	$950
2,000+	$2,650	10	$550	$3,200	NA	$1,000

Source: Abt (2023)

Leak repair. Repair costs are calculated as the base cost of making the repair or retrofit, including labor, parts, refrigerant recovery, and verification tests.[18] These costs are assumed to vary by system size, where leak repairs on a sub-small or small system are assumed to be relatively simpler and less costly than repairs on medium and large systems. The base costs associated with each outcome were estimated as described below.

- **Standard repair.** Leak repair costs for a "standard repair" are based on assumptions in CARB (2009a). CARB (2009a) surveyed RACHP service contractors and technicians to validate these cost assumptions. Although the CARB estimates did not cover appliances with charge sizes less than 50 pounds, repair costs for these smaller appliances were extrapolated from the CARB estimates.
- **Extension repair.** An "extension repair" is assumed to involve the repair of a major component such as a compressor and is based on costs presented in Stratus (2009).[19]
- **Retrofit.** Retrofit costs were also based on Stratus (2009); this analysis assumed that the cost to retrofit an entire appliance was between two to three times the cost of the compressor or major component.

As noted above, lower leak rate thresholds will result in leaks being repaired sooner than under the current approach. The analysis assumes that repairs are conducted six or ten weeks earlier as a result of these requirements. Thus, the repair costs attributable to the rule are based on the time cost of conducting

[18] Industry input suggested that verification tests are already conducted as standard practice during servicing events. Moreover, because initial and follow-up verification tests can both be conducted during the same service appointment, this requirement is not expected to result in additional servicing events. Time required to conduct the verification tests is included in the estimated time to conduct the repair.
[19] Stratus (2009) obtained estimates of retail prices for typical replacement compressors from a supplier (ThermaCom Ltd.).

those repairs six or ten weeks earlier. The interest cost (at 7 percent and 3 percent per year) of the base repair cost is attributed to the rule; this cost is referred to below as the "effective cost of repair."[20]

An "effective cost" approach was also taken for the cost of retrofitting. Appliances that are retrofitted as a result of the proposed regulation are assumed to be retrofitted five years earlier than they would have been under current practices. Thus, the effective cost of retrofitting attributable to the rule is the cost of borrowing the funds for retrofitting for five years at 7 percent (or 3 percent) per year.

Table 3-4 below presents the base and effective cost assumptions by repair, appliance charge size, and whether the appliance is using ALD. For retrofit outcomes, the base costs presented do not include the additional cost of replacing the entire refrigerant charge with virgin refrigerant. These costs can be sizable considering, for instance, charge sizes can exceed 10,000 pounds in some systems. For the standard and extension repair outcomes, the cost of refrigerant recharge is not included since it is assumed that the owner or operator would have topped off the system in the absence of the regulatory requirements.

Table 3-4: Unit Cost Assumptions for Leak Repair[a,b,c]

Appliance Size	Total Labor Hours	Parts	Refrigerant Recovery	Total Base Cost for Labor, Parts, and Recovery	Effective Cost of Early Repair / Retrofit (without ALD)		Effective Cost of Early Repair / Retrofit (with ALD)	
					7% Discount Rate	3% Discount Rate	7% Discount Rate	3% Discount Rate
Standard Repair								
Sub-small, Small	8	$135	$269	$846	$7.4	$3.2	-	-
Medium	12	$404	$471	$1,538	$13.5	$5.8	$22.4	$9.6
Large	16	$808	$876	$2,567	$22.5	$9.6	$37.4	$16.0
Extension Repair								
Sub-small, Small	20.25	$3,501	$269	$4,888	$42.8	$18.3	-	-
Medium	20.25	$12,768	$471	$14,358	$126	$53.8	$209	$89.7
Large	20.25	$12,768	$876	$14,762	$129	$55.4	$215	$92.3
Retrofit[c]								
Sub-small, Small	20.25	$10,297	$269	$11,684	$2,603–$2,761	$1,272–$1,349	-	-
Medium	20.25	$27,459	$471	$29,048	$6,671–$8,197	$3,259–$4,005	$7.902–$8,185	$3,861–$3,999
Large	20.25	$27,459	$876	$29,452	$8,373–$8,996	$4,091–$4,395	$8,387–$40,339	$4,098–$19,709

[20] CARB used a similar approach—i.e., estimating the effective cost of repair—in developing its economic impact estimates for its High-Global Warming Potential Stationary Source Refrigerant Management Program (CARB 2009b).

Source: for Standard Repair Labor Hours, Parts, and Recovery Costs: CARB (2009a); for Extension Repair and Retrofit: Stratus (2009).
[a] Assumptions for small appliances were proxied for sub-small equipment containing between 15 and 50 49 pounds of refrigerant.
[b] Total base cost is calculated by multiplying the total labor hours by the labor rate ($55.21) and adding the additional costs associated with parts and refrigerant recovery.
[c] Effective costs for repair and retrofit of appliances varies based on the charge size of the appliance replaced.

Refrigerant savings. By causing leaks to be repaired earlier, the proposed regulations would result in refrigerant cost savings for system operators. Refrigerant cost savings are calculated based on the difference between the baseline and post-repair leak rates, multiplied by the charge size, over the six weeks earlier that each repair was conducted (or ten weeks earlier for appliances using an ALD system). An average price of $4 per pound was assumed for all refrigerants, based on the average price of HFC-134a, R-404A, R-407A and R-507 assumed in the RIA for Phasing Down Production and Consumption of HFCs (EPA 2021).

On a per system basis, effective refrigerant savings range from $0.29 for sub-small school bus AC up to $4,718 for large IPR systems (EPA 2023a).

Leak repair expected costs and savings. Expected costs and burden reductions per model appliance were estimated on a weighted basis, taking into account the proportion of appliances assumed to reach each leak repair outcome and the unit costs and savings associated with each outcome. Expected costs and savings were estimated in the Vintaging Model in a disaggregated manner, distinguishing between appliance sectors, types, sizes, and refrigerant type (EPA 2023a).

3.2.2 Approach for Estimating Benefits

Annual Benefits of Leak Repair and Inspection

Similar to the methodology for estimating costs and savings, benefits were estimated using a model equipment approach. For equipment with 15 or more pounds of refrigerant containing an HFC or a substitute for an HFC that has a GWP above 53, benefits were scaled up industry-wide based on the total number of affected equipment using EPA's Vintaging Model and the approach outlined in Section 2.3.

Benefits are calculated as the refrigerant emissions prevented by repairing or retrofitting a leaking system earlier than would have been done if waiting for the system performance to decline. EPA estimates this to be on average six weeks (or ten weeks if systems are using ALD monitoring). Avoided refrigerant emissions are calculated based on the difference between the baseline and post-repair leak rates (shown in Section 0 above), multiplied by the charge size, over the six weeks or ten weeks earlier that each repair was conducted. The amount of avoided refrigerant emissions is weighted by an average

GWP. For all equipment types, weighted-average GWPs are based on average charge sizes, refrigerant type, and stock of affected equipment modeled in the Vintaging Model (EPA 2023a).

Table 3-5: Average 2025 GWP Assumptions by Equipment Type, Size, and Refrigerant Type

Sector	***Equipment Type***	***Equipment Size***	***Weighted-Average GWP***
CC	School & Tour Bus AC	Sub-Small	1,430
	Transit Bus AC	Sub-small	1,430
	Passenger Train AC	Sub-small	1,602
	Chiller	Medium	1,160 – 1,624
		Large	1,244 – 1,533
CR	Modern Rail Transport	Sub-small	2,676
	Vintage Rail Transport	Sub-small	1,430
	Condensing Unit	Sub-small	3,035
	Marine Transport	Small	3,623
		Medium	2,814 – 3,623
		Large	2,814
	Rack	Medium	2,743
		Large	2,743
	Cold Storage	Large	3,937
IPR	IPR	Medium	1,430 – 1,675
		Large	1,430 – 3,192

Source: EPA (2023a)

The benefits for the extension repair are assumed to be equivalent to the benefits of a standard repair. This analysis does not take into account the additional 30 days (or longer) that the system is leaking between filing the extension and when the actual repair takes place, which could result in overestimating the avoided emissions as a result of the extension request. However, because systems requiring an extension repair have typically more complicated or catastrophic leaks, an extension repair as a result of the proposed regulations would still be taking place earlier than it would under the baseline scenario, and emissions would still be avoided.

Although emission benefits associated with retrofit are anticipated, none are calculated in this analysis. The benefits associated with retrofit fall outside of the one-year timeframe of this analysis (i.e., end users have 30 days to make the initial repair, 30 days to prepare and submit a retrofit plan, and then a full year to complete the retrofit and repair all additional leaks), and thus are not included. Furthermore, because this analysis only considers a one-year period, it does not include benefits from preventing a chronically leaking system from continued operation over a longer time period than one year.

On a per appliance basis, effective benefits range from 0.05 metric tons of carbon dioxide (CO_2) equivalent ($MTCO_2eq$) for sub-small school bus AC systems up to 2,477 $MTCO_2eq$ for very large cold storage refrigeration systems (EPA 2023a).

Model Equipment Expected Benefits. Expected benefits per model equipment were estimated on a weighted basis, taking into account the proportion of equipment assumed to reach each leak repair outcome (see Table 3-1 above) and the avoided refrigerant emissions associated with each outcome. Expected benefits were estimated in the model in a disaggregated manner, distinguishing between equipment sectors, types, sizes, and refrigerant type. The expected avoided refrigerant emissions per model equipment type (as described above) were multiplied by the number of each type of equipment assumed to experience leaks above the rule's threshold leak rates (see Table 2-2**Error! Reference source not found.** above). This yields aggregate benefits for the United States as a whole as shown in Table 3-6**Error! Reference source not found.** below.

Table 3-6: Expected Emissions Reductions in 2025 by Equipment Type and Size

Sector	***Equipment Type***	***Equipment Size***	***GHG Emissions Avoided ($MTCO_2eq$)***
CC	School & Tour Bus AC	Sub-small	3,000
	Transit Bus AC	Sub-small	1,800
	Passenger Train AC	Sub-small	1,100
	Chiller	Medium	512,500
		Large	17,900
CR	Modern Rail Transport	Sub-small	1,400
	Vintage Rail Transport	Sub-small	2,200
	Condensing Unit	Sub-small	61,400
	Marine Transport	Small	74,700
		Medium	383,200
		Large	11,500
	Rack	Medium	306,700
		Large	353,900
	Cold Storage	Large	185,500
IPR	IPR	Medium	36,000
		Large	1,849,200

Future Annual Benefits of Leak Repair and Inspection

The analysis described above estimates one-year benefits based on the current distribution of HFC appliances in use. However, because the use of HFCs will change over the next decade due to the phase-down of HFCs in accordance with the AIM Act 2024 Allocation Rule, benefits for the proposed regulations to the program will also change. Future benefits were estimated using a model equipment, facility, and entity approach. Benefits were then scaled up industry-wide based on the total number of affected appliances anticipated in 2030, 2040, and 2050.

Several assumptions were made to simplify the process of determining the number of affected appliances and the benefits of leak repair in 2030, 2040, and 2050:

- Appliances used in later years are assumed to have the same leak rates and charge sizes as those in the 2025 baseline scenario.
- The same proportion of standard repairs, extension repairs, and retrofits are assumed for all years.
- The affected HFC appliances in 2025 are assumed to grow according to the growth rate, lifetime, and transitions in EPA's Vintaging Model—with the adjustments described below.

The growth in stock of HFC appliances was adjusted to account for the Allocation Framework rule and the 2024 Allocation Rule RIA addendum. Benefits from the transition away from HFCs were quantified and recently presented in the RIA for the EPA final rulemaking, *Phasedown of Hydrofluorocarbons: Allowance Allocation Methodology for 2024 and Later Years* (AIM Act 2024 Allocation Rule) (Docket No. EPA-HQ-OAR-2022-0430) (EPA 2022a). To avoid double-counting benefits, this analysis assumes that HFC CR, CC, and IPR appliances begin transitioning away from HFCs in accordance with the transition scenario presented in the RIA Addendum for the AIM Act 2024 HFC Allocation Rule.[21]

Appliance-specific average GWP values were also updated to reflect the specific mix of HFC refrigerants assumed in 2030, 2040, and 2050, as shown in Table 3-7**Error! Reference source not found.**. GWP values in 2030, 2040, and 2050 include HFCs and substitutes alternatives such as HFOs and HCFOs, but did not include other substitutes such as CO_2, ammonia, or hydrocarbons.[22] Affected equipment modeled in EPA's Vintaging Model, which was the basis for the RIA analysis for the AIM Allocation Framework Rule and the RIA Addendum for the 2024 Allocation Rule, were distributed into three size categories (as

[21] Different types of appliances are assumed to transition in different years as presented on pp. 72-74 of the 2024 Allocation Rule RIA Addendum (EPA 2022a).

[22] Given the GWPs of HFOs, HCFOs, CO_2, ammonia, and hydrocarbons are very low compared to regulated HFCs, the is not expected to affect the weighted-average GWP significantly.

discussed in Section 2.3) and therefore all size categories for some equipment types have the same weighted-average GWP.

Table 3-7: Average GWP Assumptions by Equipment Type, Size, and Refrigerant Type for 2030, 2040, and 2050

Sector	Equipment Type	Equipment Size	Weighted-Average GWP		
			2030	2040	2050
CC	School & Tour Bus AC	Sub-small	1,430	1,430	1,430
	Transit Bus AC	Sub-small	1,430	1,430	1,430
	Passenger Train AC	Sub-small	1,602	1,602	1,602
	Unitary AC	Sub-small	1,717	836	730
	Chiller	Medium	907 – 1,394	229 – 839	6 – 698
		Large	1,030 – 1,122	688 – 716	435 – 618
CR	Modern Rail Transport	Sub-small	2,676	2,676	2,676
	Vintage Rail Transport	Sub-small	1,430	-	-
	Condensing Unit	Sub-small	2,611	1,966	1,966
	Marine Transport	Small	3,654	3,662	3,662
		Medium	2,812 – 3,654	2,811 – 3,662	2,811 – 3,662
		Large	2,812	2,811	2,811
	Rack	Medium	2,518	2,479	2,479
		Large	2,518	2,479	2,479
	Cold Storage	Large	3,937	3,937	-
IPR	IPR	Medium	1,430 – 1,693	1,430 – 1,701	-
		Large	1,430 – 3,191	1,430 – 3,191	-

Note: By 2040, there are no longer any HFC refrigerants assumed in vintage rail transport systems. By 2050, there are no longer any HFC refrigerants assumed in cold storage and IPR systems.

Benefits on a per-appliance basis were then calculated in the same manner outlined in Section 0 and were multiplied by the estimated affected appliances in 2030, 2040, and 2050 described above as shown in Table 3-8.

Table 3-8: Expected Emissions Reductions by Equipment Type, Size, and Refrigerant Type for 2030, 2040, and 2050

Sector	Equipment Type	Equipment Size	MTCO2eq		
			2030	2040	2050
CC	School & Tour Bus AC	Sub-small	3,300	3,800	4,100
	Transit Bus AC	Sub-small	2,000	2,300	2,500
	Passenger Train AC	Sub-small	1,200	1,300	1,400
	Chiller	Medium	479,800	218,600	131,500

		Large	15,800	12,200	9,300
CR	Modern Rail Transport	Sub-small	1,500	1,600	1,700
	Vintage Rail Transport	Sub-small	800	-	-
	Condensing Unit	Sub-small	57,300	44,200	48,700
	Marine Transport	Small	97,000	123,800	139,600
		Medium	498,400	635,500	716,300
		Large	15,200	19,200	20,900
	Rack	Medium	304,700	335,000	365,400
		Large	351,600	386,500	421,600
	Cold Storage	Large	160,100	64,100	-
IPR	IPR	Medium	29,900	13,400	-
		Large	1,774,400	922,300	-

Note: By 2040, there are no longer any HFC refrigerants assumed in vintage rail transport systems. By 2050, there are no longer any HFC refrigerants assumed in cold storage and IPR systems.

3.3. Costs and Benefits for Reclamation Provisions

The proposed requirement to use reclaimed refrigerant to fill new equipment and service existing systems across numerous refrigeration and AC subsectors would reduce the need for virgin production of refrigerant, which some research indicates could result in cost-savings and benefits. Yasaka et al. (2023) performed a life cycle assessment for the virgin production, destruction, and reclamation of R-410A, HFC-32, and HCFC-22 in Europe and Japan and found that the reclamation process had lower energy consumption and costs and emitted fewer GHG emissions compared to production and destruction, regardless of the refrigerant type or plant location. Because these cost and emission estimates aren't available specifically in the United States context, cost savings and benefits are not directly incorporated into the overall compliance costs and benefit estimates associated with this rulemaking; however, an analysis of potential cost savings and benefits estimated by applying the incremental costs and emissions associated with virgin production, destruction, and reclamation to estimated demand for new equipment and servicing are presented for reference in Appendix B.

3.4. Costs and Benefits Related to Alternative Standards for Reclamation

The purpose of the RCRA alternative standards for ignitable spent refrigerant proposed in this rule is to help reduce emissions of ignitable spent refrigerants to the lowest achievable level by maximizing the recapture and safe reclamation/recycling of such refrigerants during the maintenance, service, repair, and disposal of appliances. To the extent that the new alternative standards incentivize reclamation of ignitable spent refrigerant over disposal, the RCRA alternative standards would result in the same type of life cycle benefits that the proposed required use of reclaimed refrigerant to fill new equipment and service existing systems would garner. The proposed RCRA alternative standards also are expected to result in an overall reduction in compliance cost for management of ignitable spent refrigerant under RCRA. Avoided costs include reduced transportation cost (hazardous waste manifest and transporter not required under the alternative standards), avoided compliance cost of complying with hazardous waste generator regulations for appliance owners and technicians, and avoided hazardous waste incineration costs for recovered ignitable spent refrigerant. Offsetting these avoided costs would be the cost to reclaimers for meeting the new standards for emergency preparedness and response, and for documenting that the ignitable spent refrigerant is not speculatively accumulated.

Because these cost estimates are heavily dependent on the future market for ignitable spent refrigerant sent for reclamation, which is difficult to predict with currently available data, cost savings and benefits of the proposed RCRA standards are not directly incorporated into the overall compliance costs and benefit estimates associated with this rulemaking. However, because the alternative RCRA standards are voluntary, and regulated entities can always choose to continue to comply with the full RCRA standards if that is the economically preferred option, EPA anticipates that the proposed RCRA alternative standards would either be economically neutral or result in an overall cost saving and increase in reclamation of ignitable spent refrigerants.

3.5. Costs and Benefits for Handling of Disposable Cylinders and Container Tracking

EPA is proposing to require that disposable cylinders that contain HFCs and that have been used for the servicing, repair, or installation of refrigerant-containing equipment or fire suppression equipment must be sent to an EPA-certified reclaimer or a fire suppressant recycler. EPA is proposing that the EPA-certified reclaimer or fire suppressant recycler who receives the disposable cylinder must remove all the HFCs before disposing of the cylinder.

EPA is proposing that disposable and refillable containers of HFCs that could be used for servicing, repair, or installation of refrigerant-containing equipment or fire suppressant equipment must include a machine-readable tracking identifier.[23] EPA is also proposing certain requirements for the registration in a tracking system used to generate machine-readable tracking identifiers as well as update tracking information as containers of HFCs moves in the distribution chain. Additionally, EPA is proposing

[23] As noted in the proposal for this rulemaking, EPA established certain requirements for use of refillable cylinders and a QR codes system of tracking under the Allocation Framework Rule. Those requirements were subject to judicial review in the D.C. Circuit, and the court concluded that "EPA has not identified a statute authorizing its QR-code and refillable-cylinder regulations" and therefore vacated those parts of the rule and remanded to the EPA. *Heating, Air Conditioning & Refrigeration Distributors Int'l v. EPA*, 71 F.4th 59, 68 (D.C. Cir. 2023) ("*HARDI v. EPA*"). The court rejected the other challenges to the Allocation Framework Rule in this litigation. *Id.* at 61.

requirements for the tracking of the disposable and refillable cylinders as they are sent to an entity either capable of removing the remaining heel or, in the case of refillable cylinders, refilling the cylinder.

Currently, users of cylinders arrange for the handling and transportation of used cylinders to recycling facilities. The provisions requiring transporting the used cylinders to a reclaiming facility is not expected to increase costs on the cylinder user, as the same handling and transportation will be needed, only to a different site. In some instances, reclaimers may even arrange the collection of used cylinders to maximize their acquisition of raw material for their business, and this could result in cost savings for users of refillable and disposable cylinders. The costs of reclaimers receiving used cylinders is covered under recordkeeping and reporting costs. An analysis of the estimated incremental climate benefits of cylinder provisions proposed in this rule are presented in Appendix C.

3.6. Costs and Benefits for Reducing Emissions in the Fire Suppression Sector

The proposed rule contains provisions requiring the use of recycled HFCs for initial charge and for servicing/repairing equipment. Avoiding the consumption and eventual release of these gases through provisions aimed at maximizing the use of recycled as opposed to virgin HFCs and could result in significant climate benefits. EPA has provided an analysis of these potential benefits in Appendix D of this RIA Addendum.

Given EPA previously assumed in the Allocation Framework Rule RIA and 2024 Allocation Rule RIA Addendum analyses that a significant portion of the HFC market for fire suppression equipment would transition to lower-GWP alternatives in response to the HFC phasedown, these previously quantified benefits are excluded from total potential benefits to avoid double counting. In other words, only the residual market share previously assumed not to transition away from HFCs is used as the basis from which potential benefits are evaluated. Incremental benefits of the provisions are then analyzed under two scenarios: 1) a base case which assumes benefits of reducing the use of virgin HFCs in the fire suppression sector are offset by use of virgin HFCs in sectors not covered by this rule (given the flexibility of the HFC allowance trading mechanism); and 2) a high additionality case where these offsetting effects are not assumed. More details on the approach can be found in Appendix D.

3.7. Reporting and Recordkeeping Costs

The proposed regulations associated with recordkeeping and reporting are expected to result in compliance costs associated with the requirements for recordkeeping and reporting for owners and operators of fire suppression equipment and of refrigerant-containing appliances that contain HFCs or a substitute for an HFC with a GWP above 53. Additional recordkeeping and reporting costs are associated with the requirements to track cylinders by means of a machine-readable tracking identifier, and to include a certification that reclaimed refrigerant contains no more than 15 percent virgin HFC. All recordkeeping and reporting costs are calculated by multiplying the estimated burden (hours) times the average annual respondent hourly cost (labor plus overhead).

In deriving these costs, EPA identified applicable standard occupational classification for each respondent and used the corresponding 2021 median hourly rate from the Bureau of Labor Statistics (BLS 2022). The resulting costs outlined in Table 3-9 are the average hourly administrative cost of labor plus overhead for private firms.

Table 3-9: Labor Rates

Respondent	Bureau of Labor Statistics Information			Total
	Standard Occupational Classification	Occupational Title	Median Wage	
Technicians	49-9021	Heating, Air-Conditioning, and Refrigeration Mechanics and Installers	$26.29	**$55.21**
Owners/ Operators	17-2111	Health and Safety Engineers	$47.93	**$100.65**

To generate costs, the incremental annual burden (in hours) was estimated for each recordkeeping and reporting requirement associated with extending the leak repair and inspection requirements to HFC equipment and multiplied by the hourly wage rate.

Requests for extensions to the leak repair and retrofit timelines. Owners or operators of CC, CR, and IPR appliances normally containing 15 or more pounds of HFC refrigerant can apply to EPA for an extension to the leak repair and appliance retrofit timeframe.

The total number of extension requests for CC, CR, and IPR HFC equipment was estimated by scaling the number of extension requests estimated for ODS equipment in the supporting ICR 1626.18[24] based on the proportion of total HFC equipment to ODS equipment modeled in EPA's Vintaging Model.

Installation records.

Consistent with the ICR, this analysis assumes 1.5 minutes of burden time each time a refrigerant-containing appliance that contains an HFC or a substitute for an HFC with a GWP greater than 53 is installed. EPA's Vintaging Model assumptions described in Section 2.3 were used to identify the pool of affected appliances (i.e., new appliances with charge sizes of an HFC or HFC substitute with a GWP greater than 53 at or above 15 pounds).

Purchase and service records.

Consistent with the ICR, this analysis assumes 1.5 minutes of burden time each time a refrigerant-containing appliance that contains an HFC or a substitute for an HFC with a GWP greater than 53 is serviced.[25] EPA's Vintaging Model assumptions described in Section 2.3 were used to identify the pool of affected appliances (i.e., all HFC or substitute appliances with charge sizes at or above 15 pounds) and the expected number of times that the affected appliances would be serviced. The total number of servicing events is assumed to be equal to the number of times that service technicians provide invoices (i.e., one time per year for all appliances with charge sizes at or above 15 pounds).

Results of verification tests. EPA is proposing leak repair regulations that require initial and follow-up verification tests on repairs made after the leak rate threshold is exceeded for a refrigerant-containing appliance that contains an HFC or a substitute for an HFC with a GWP greater than 53. EPA's Vintaging Model was used to identify the affected pool of appliance (as described in Section 2.3). For every occurrence of an appliance exceeding the applicable leak rate threshold, 1.5 minutes of burden time was assumed to maintain reports on the results of verification tests.

Leak inspections. This action proposes that covered CR and IPR appliances with a charge size less than 500 pounds or CC and other appliances with a charge size of at least 15 pounds conduct a leak inspection once per calendar year until the owner or operator can demonstrate through leak detection calculations

[24] ICR 1626.18 was developed to estimate burden associated with reporting and recordkeeping of leak repair and inspection requirements for appliances containing more than 50 pounds of ODS refrigerant.

[25] This assumption is premised on service technicians already needing to record information on services for invoicing, so the only incremental burden is in saving the data to a record file. For the significant percentage of service companies that record service information digitally in apps or other software, no time at all is needed to save logged data.

that the appliance has not leaked in excess of the applicable leak rate for one year. CR and IPR appliances with a charge size from 500 pounds up to 1,500 pounds would be required to conduct a leak inspection quarterly (i.e., once per three-month period). Appliances, or portions of appliances, continuously monitored with an ALD system that is certified annually, including appliances with a charge size of 1,500 or more pounds, would not be required to conduct an annual leak inspection. This analysis assumes that the recordkeeping time associated with maintaining leak inspection records is one minute. EPA's Vintaging Model was used to identify the affected pool of appliances (as described in described in Section 2.1).

Plans to retrofit appliances. EPA is proposing that owners or operators of IPR, CC, and CR appliances normally containing 15 or more pounds of a refrigerant containing an HFC or a substitute for an HFC with a GWP greater than 53 must develop and maintain a plan to retire or retrofit the appliance in the following cases after the applicable leak rate is exceeded: an owner or operator chooses to retrofit or retire rather than repair a leak, an owner or operator fails to take action to repair or identify a leak, or an appliance continues to leak above the applicable leak threshold after a repair attempt was made. The total number of retrofit requests for CC, CR, and IPR appliances containing 15 or more pounds of a refrigerant containing an HFC or a substitute for an HFC with a GWP greater than 53 was estimated as 1 percent of all affected equipment leaking above the threshold (see Table 3-1). For each retrofit plan, 8 hours of burden time was assumed.

Reports on systems that leak 125 percent or more. EPA is proposing to require owners/operators of appliances subject to the leak repair and inspection provisions to prepare and submit reports describing efforts to identify and repair leaks for appliances that leak 125 percent or more of the full charge in a calendar year. Using the assumptions in the ICR for ODS equipment and scaling proportionately based on the ratio of affected ODS and HFC appliances, this analysis estimates that approximately 417 appliances have an annual leak rate greater than 125 percent (i.e., approximately 288 requests for equipment above 50 pounds and approximately 129 requests for equipment containing between 15 and 50 pounds of refrigerant). For each appliance meeting or exceeding this leak rate threshold, 1 hour of burden time was assumed to prepare and submit a report for each occurrence.

Requests to cease a retrofit plan. EPA is proposing to require owners/operators of refrigerant-containing appliances containing 15 or more pounds of an HFC or a substitute for an HFC with a GWP greater than 53 to submit a request to cease a retrofit if certain requirements are met, including an agreement to repair all identified leaks within one year of the retrofit plan's date. To estimate the costs for this new reporting requirement, it was assumed that 5 percent of those that develop a retrofit plan will submit a request to cease their retrofit (i.e., approximately 67 requests for equipment above 50 pounds and approximately 89 requests for equipment containing between 15 and 50 pounds of refrigerant). Each request is assumed to take 30 minutes to complete.

Annual calibration of ALD system. EPA is proposing to require owners/operators of refrigerant-containing appliances using ALD systems to maintain records regarding the annual calibration or audit of the ALD system. Records must be maintained each time an ALD system detects a leak, whether that be based on the applicable ppm threshold for a direct ALD system, or the indicated loss of refrigerant measured in the ALD system. EPA assumes indirect ALD systems will collect and store this directly and no burden is assumed. For owners/operators of direct ALD systems, 1 minute of burden time is assumed.

Cylinder tracking: The total number of cylinder scans required by each respondent (i.e., producer, importer, reclaimer, filler/packager, fire suppression agent recycler, supplier) was estimated based on industry input that there are 4.5 million cylinders in circulation in the United States. Producers, importers, and fillers/packagers were assumed to scan/enter information into the tracking system once in the supply chain. Reclaimers and fire suppression agent recyclers were assumed to scan/enter information into the tracking system twice in the supply chain to account for returned cylinders. To account for half of the cylinders that are returned to the reclaimer or fire suppression agent recycler being distributed through a supplier, suppliers were assumed to scan/enter information into the tracking system 1.5 times in the supply chain. Registration with the system was assumed to take half an hour for each respondent, and it was assumed to take 2 hours per response for producers and importers to enter data into the system, 20 seconds for reclaimers, fillers/packagers, and fire suppression agent recyclers to scan cylinders into the system, and 10 seconds for suppliers to scan cylinders into the system.

Labeling of reclaimed material with no more than 15% virgin material: It was assumed that reclaimers already label material and, therefore, will only need to redesign labels to indicate the batch contains no more than 15% virgin material. The label redesign was assumed to require 9 hours of both graphic design and administrative work.

3.8. Monetization of Emissions Benefits

The primary benefits of this proposed rule would derive mostly from preventing the emissions of HFCs, thus reducing the damage from climate change that would have been induced by those emissions. The 18

HFCs and their isomers regulated under the AIM Act are GHGs that can trap much more heat per ton emitted than CO_2, a ratio shown in each chemical's GWP. The ratio of the amount of heat trapped by one ton of a chemical in the 100 years after it is emitted to the amount of heat trapped by one ton of CO_2 in 100 years after being emitted is the chemical's 100-year GWP, and the HFCs regulated under the phasedown have 100-year GWPs ranging from 53 to 14,800[26], with the vast majority of HFCs emitted having GWPs over 1,000. Prior to HFC regulation under the AIM Act, it was anticipated that HFC use and emissions would continue to rise, helping to drive global climate change. Thus, reducing the amount of HFCs that are used and emitted prevents climate damage and associated social costs that would have been induced by those HFC emissions. A more complete discussion of climate change damages and the social benefits of preventing them can be found in Sections 4.1 and 4.2 of the Allocation Framework Rule RIA.

While there may be other benefits to phasing down HFCs, the benefits monetized in this analysis are limited to the climate benefits of reduced HFC emissions.

3.8.1 Social Cost of HFCs

While CO_2 is the most prevalent GHG emitted by humans, it is not the only GHG with climate impacts. The EPA Endangerment Finding (2009) defined a basket of six gases as the GHG air pollutant addressed in the finding, comprising CO_2, methane (CH_4), nitrous oxide (N_2O), HFCs, perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). The climate impact of the emission of a molecule of each of these gases is generally a function of their lifetime in the atmosphere and the radiative efficiency of that molecule.[27] We estimate the climate benefits for this rulemaking using a measure of the social cost of each HFC (collectively referred to as SC-HFC) that is affected by the rule. The SC-HFC is the monetary value of the net harm to society associated with a marginal increase in HFC emissions in a given year, or the benefit of avoiding that increase. In principle, SC-HFC includes the value of all climate change impacts, including (but not limited to) changes in net agricultural productivity, human health effects, property damage from increased flood risk and natural disasters, disruption of energy systems, risk of conflict, environmental migration, and the value of ecosystem services.[28] The SC-HFC, therefore, reflects the societal value of

[26] EPA has determined that the exchange values included in subsection (c) of the AIM Act are identical to the 100-year GWPs included in IPCC (2007). In this context, EPA uses the terms "global warming potential" (or GWP, measured in units of $MMTCO_2e$) and "exchange value" (measured in units of MMTEVe) interchangeably. One MMTEVe is therefore equivalent to one $MMTCO_2e$.

[27] In the case of CH_4, the climate effect can encompass the atmospheric reactions of the gas that change the abundance of other substances with climatic effects, such as ozone (O_3) and stratospheric water vapor (H_2O).

[28] Since the SC-HFC estimates are based on the same methodology underlying the SC-GHG estimates presented in the IWG February 2021 TSD, they share a number of limitations that are common to those SC-GHG estimates. The IAMs used to produce those interim estimates do not include all of the important physical, ecological, and economic impacts of climate change recognized in the climate change literature and the science underlying their "damage functions" — i.e., the core parts of the

reducing emissions of the HFC in question by one metric ton. The SC-HFC is the theoretically appropriate value to use in conducting benefit-cost analyses of policies that affect HFC emissions.

The monetization of climate benefits in this analysis uses the same HFC-specific SC-HFC estimates as the estimation of the benefits in the Allocation Framework Rule RIA. The SC-HFC values are listed in 2020 dollars per metric ton of HFC emitted by year. The SC-HFC increases over time within the models—i.e., the societal harm from one metric ton emitted in 2030 is higher than the harm caused by one metric ton emitted in 2025—because future emissions produce larger incremental damages as physical and economic systems become more stressed in response to greater climatic change, and because gross domestic product (GDP) is growing over time and many damage categories are modeled as proportional to GDP. A more complete discussion of the development of these SC-HFC estimates can be found in section 4.1 of the Allocation Framework Rule RIA.

EPA has developed a draft updated SC-GHG methodology within a sensitivity analysis in the regulatory impact analysis of EPA's November 2022 supplemental proposal for oil and natural gas emissions standards that is currently undergoing external peer review and a public comment process. While that process continues EPA is continuously reviewing developments in the scientific literature on the SC-GHG, including more robust methodologies for estimating damages from emissions, and looking for opportunities to further improve SC-GHG estimation going forward. Most recently, EPA presented a draft set of updated SC-GHG estimates within a sensitivity analysis in the regulatory impact analysis of EPA's December 2022 supplemental proposal for oil and gas standards that that aims to incorporate recent advances in the climate science and economics literature.[29] Specifically, the draft updated methodology incorporates new literature and research consistent with the National Academies near-term recommendations on socioeconomic and emissions inputs, climate modeling components, discounting approaches, and treatment of uncertainty, and an enhanced representation of how physical impacts of climate change translate to economic damages in the modeling framework based on the best and readily adaptable damage functions available in the peer reviewed literature. EPA solicited public comment on the sensitivity analysis and the accompanying draft technical report, which explains the methodology underlying the new set of estimates, in the docket for the proposed oil and natural gas rule. EPA is also

IAMs that map global mean temperature changes and other physical impacts of climate change into economic (both market and nonmarket) damages — lags behind the most recent research. For example, limitations include the incomplete treatment of catastrophic and non-catastrophic impacts in the integrated assessment models, their incomplete treatment of adaptation and technological change, the incomplete way in which inter-regional and intersectoral linkages are modeled, uncertainty in the extrapolation of damages to high temperatures, and inadequate representation of the relationship between the discount rate and uncertainty in economic growth over long time horizons. Please see section 4 of the Allocation Framework Rule RIA for a complete discussion of the limitations associated with the SC-HFC estimates used in this analysis.

[29] Standards of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and Natural Gas Sector Climate Review (87 FR 74702, December 6, 2022).

completed an external peer review of this technical report. The agency is in the process of reviewing public comments on the updated estimates within the oil and natural gas rulemaking docket as well as the recommendations of the external peer reviewers. EPA remains committed to using the best available science in its analyses. Thus, if EPA's updated SC-GHG methodology is finalized before this rule is finalized, EPA intends to present monetized climate benefits using the updated SC-GHG methodology in the final RIA.

3.8.2 SC-HFC and Discount Rates

Climate damages due to emissions of a greenhouse gas accumulate for many years after emission as the gas remains in the atmosphere trapping heat, and then as the trapped heat continues to cause damages. Therefore, the SC-HFC value for a particular HFC in a given emission year is highly dependent on the way the future damages are discounted back to the year of emissions. As explained in Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under E.O. 13990,[30] it is appropriate for agencies to revert to the same set of four values drawn from the social cost of greenhouse gases (SC-GHG)[31] distributions based on three discount rates as were used in regulatory analyses between 2010 and 2016 and subject to public comment (2.5 percent, 3 percent, and 5 percent), plus a fourth value, selected as the 95th percentile of estimates based on a 3 percent discount rate. The fourth value was included to provide information on potentially higher-than-expected economic impacts from climate change, conditional on the 3 percent estimate of the discount rate. In that document it was also found that the use of the social rate of return on capital (7 percent under current OMB Circular A-4 guidance) to discount the future benefits of reducing GHG emissions inappropriately underestimates the impacts of climate change for the purposes of estimating the SC-GHG. For purposes of capturing uncertainty around the SC-HFC estimates in analyses, we emphasize the importance of considering all four values for each HFC affected by the rule.

3.9. Other Potential Benefits of this Rule

As detailed in Section 3.2.2, the estimated benefits of this proposed rule that are quantified and presented in this analysis are the benefits of avoiding GHG emissions that would contribute to climate damages.

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[30] Interagency Working Group on Social Cost of Greenhouse Gases, United States Government (2021), 86 FR 24669, available at https://www.whitehouse.gov/wp-content/uploads/2021/02/TechnicalSupportDocument_SocialCostofCarbonMethaneNitrousOxide.pdf.

[31] SC-GHG refers collectively to social costs of different greenhouse gases, e.g., SC-CO2, SC-CH4, and SC-HFC. In each case it is the monetized net social cost of a marginal increase in emissions of the GHG, or the benefit of avoiding that increase.

There are, however, additional potential benefits that would follow from the provisions proposed but that are not quantified.

The proposed provisions that would require leak inspections, the repair of leaks, and/or the installation of ALD systems for certain appliances are best practices for the maintenance and upkeep of RACHP appliances. As described in Section **Error! Reference source not found.**, following such best practices accrues benefits for the owner/operator of the appliance by reducing the loss of refrigerant, resulting in savings. A regular practice of inspecting equipment and repairing leaks when detected (rather than topping-up the appliance) also prevents equipment from breaking down as often and can prolong the effective service life of appliances.[32] Fewer repairs of broken appliances and extending their service life directly benefits owner/operators, and in the case of refrigeration equipment reducing equipment failures has the additional benefit of reducing the loss of refrigerated stock.[33] The costs of a refrigeration appliance at a retail store failing and thousands of pounds of perishable stock being lost are considerable, and the aggregate costs of such food waste to the U.S. economy are also significant. In 2021, approximately 344,000 MT of food were lost due to equipment issues in the retail and food service sectors, with a value of $1.87 billion.[34]

The provisions of this rule designed to maximize reclaim would provide a number of additional benefits that are not quantified. As the HFC phasedown progresses, the supply of virgin HFCs will be reduced, but the demand for refrigerants, fire suppression agents, aerosol propellants, etc. will continue to grow. Many uses of HFCs will transition to using substitutes, but it is expected that some demand for HFCs will continue based on the agency's experience with the ODS phaseout. For example, although halons have not been produced or imported into the United States for decades, recycled halons are still used for the initial charging and servicing of certain fire suppression equipment. Reclaimed and recycled HFCs will be needed to meet the continuing demand and to meet certain requirements in the proposed Rule.

By avoiding supply shortages of HFCs that are still needed for servicing certain appliances, maximizing reclaim avoids the economic disruption that might occur, including the stranding of equipment. A robust supply of reclaimed refrigerant would also protect the cold chain needed to deliver food and vaccines. Maximizing reclaim would also benefit sectors not directly covered by provisions of this rule due to the interdependency of the HFC supply markets through the HFC allocation system. Certain specialized uses that cannot use reclaimed HFCs are expected to continue to require virgin HFCs, for example MDIs for

[32] Crippa, 2021; Barnish, 1997
[33] Brush, 2011
[34] ReFED Insights Engine 2020

the treatment of asthma and COPD. Increased use of reclaimed HFCs in refrigeration and other sectors will free up virgin HFCs for uses such as MDIs.

3.10. Costs and Benefits under a Marginal Abatement Cost Methodology

Appendix K analyzes certain provisions of the proposed Rule using a Marginal Abatement Cost (MAC) approach. The methodology to construct a MAC Curve and how it can be used to evaluate the potential costs from a list of abatement options to meet regulatory requirements are discussed in the Allocation Framework Rule RIA. The approach offers a modified perspective of the costs and benefits of the proposed Rule.

4. Economic Impact Analysis of Leak Repair and Inspection provisions

This section summarizes the estimated impacts associated with the Agency's proposed leak repair and inspection regulations under subsection (h). These results were generated for the equipment types characterized in Section 2, using the methodology described in Section 3. All costs and savings are provided in 2022 dollars and based on current appliance distributions.

To provide a full range of costs, savings, and benefits estimates, Appendix F presents analysis of an alternative policy option considering a 5 pound-equipment threshold and the associated costs, savings, and benefits for equipment between 5 and 50 pounds in 2025 and 2035. In addition, Appendix H presents an analysis on the potential economic impacts to small businesses and governments.

4.1. Annual Leak Repair Compliance Costs

In 2025, EPA's proposed regulations are expected to result in compliance cost for each equipment sector and type category as shown in Table 4-1.

Table 4-1: Aggregate Compliance Costs by Sector, Equipment Type, and Size[a]

Sector	Equipment Type	Equipment Size	2025	2030	2040	2050
CC	School & Tour Bus AC	Sub-small	$8,117,200	$8,906,500	$10,134,400	$10,979,000
	Transit Bus AC	Sub-small	$2,871,100	$3,150,300	$3,584,600	$3,883,400

	Passenger Train AC	Sub-small	$437,900	$484,200	$530,700	$574,700
	Chiller	Medium	$12,447,500	$15,028,900	$16,333,100	$17,690,200
		Large	$86,800	$95,400	$111,200	$124,100
CR	Modern Rail Transport	Sub-small	$728,700	$747,100	$799,500	$865,900
	Vintage Rail Transport	Sub-small	$722,700	$274,500	$0	$0
	Condensing Unit	Sub-small	$24,522,400	$26,608,200	$27,242,400	$30,055,100
	Marine Transport	Small	$1,460,400	$1,882,400	$2,395,600	$2,702,700
		Medium	$7,871,000	$9,877,500	$12,527,000	$14,108,200
		Large	$508,900	$400,500	$467,000	$507,500
	Rack	Medium	$67,315,500	$47,774,500	$52,713,100	$57,283,800
		Large	$63,506,400	$45,367,700	$50,016,800	$54,337,800
	Cold Storage	Large	$2,208,200	$488,700	$210,900	$0
IPR	IPR	Medium	$1,252,400	$1,031,500	$461,200	$0
		Large	$71,241,900	$14,563,300	$6,741,700	$0
Reporting and Recordkeeping			$11,787,800	$13,341,400	$14,509,400	$15,761,100

[a] Costs are displayed using a 3 percent discount rate.

EPA's proposed leak inspection, leak repair, ALD, recordkeeping, and reporting regulations are expected to result in total incremental present value (PV) compliance costs (net of refrigerant savings) of approximately $3.6 billion based on a 3% discount rate, discounted back to 2024, as shown in Table 4-2. EPA also presents the equivalent annualized value (EAV), which represents a flow of constant annual values that, had they occurred in each year from 2024 to 2050, would yield a sum equivalent to the present value (PV).

Table 4-2. Incremental Annual Compliance Costs, Including Refrigerant Savings (2022$)

Year	Total Incremental Compliance Costs (3% Discount Rate)	Refrigerant Savings	Total Incremental Compliance Costs Minus Refrigerant Savings (3% Discount Rate)
2025	$278,400,000	$13,100,000	$265,300,000
2026	$219,100,000	$13,400,000	$205,700,000
2027	$229,900,000	$13,600,000	$216,300,000
2028	$242,700,000	$13,700,000	$229,000,000
2029	$250,000,000	$13,900,000	$236,100,000
2030	$190,600,000	$13,900,000	$176,700,000
2031	$191,900,000	$14,000,000	$177,900,000
2032	$192,700,000	$14,000,000	$178,700,000
2033	$193,600,000	$14,000,000	$179,600,000
2034	$194,300,000	$13,900,000	$180,400,000
2035	$194,500,000	$13,700,000	$180,800,000
2036	$194,600,000	$13,400,000	$181,200,000
2037	$195,200,000	$13,100,000	$182,100,000

2038	$195,700,000	$12,800,000	$182,900,000	
2039	$196,100,000	$12,500,000	$183,600,000	
2040	$196,500,000	$12,200,000	$184,300,000	
2041	$196,800,000	$11,900,000	$184,900,000	
2042	$197,100,000	$11,600,000	$185,500,000	
2043	$197,300,000	$11,200,000	$186,100,000	
2044	$197,500,000	$10,900,000	$186,600,000	
2045	$197,800,000	$10,600,000	$187,200,000	
2046	$198,400,000	$10,300,000	$188,100,000	
2047	$199,200,000	$10,200,000	$189,000,000	
2048	$200,300,000	$10,100,000	$190,200,000	
2049	$201,600,000	$10,100,000	$191,500,000	
2050	$203,300,000	$10,200,000	$193,100,000	
		Discount Rate	**3%**	**7%**
		NPV	**$3,395,000,000**	**$2,203,000,000**
		EAV	**$196,000,000**	**$199,000,000**

4.2. Refrigerant Costs and Savings in 2025 by Rule Component

Total annual savings associated with reduced refrigerant use are estimated to be $13 million. Table 4-3 below shows the annual savings by rule component. As noted in Section **Error! Reference source not found.**, the leak repair requirement is expected to result in refrigerant savings for system owners or operators due to earlier leak repair action.

Table 4-3. Total Annual Refrigerant Savings in 2025 (2022$) and Combined Annual Cost and Annual Savings with 7% and 3% Discount Rate

Rule Component	**Annual Refrigerant Savings**	**Incremental Compliance Costs**	**Combined Annual Savings and Compliance Costs**	**Incremental Compliance Costs**	**Combined Annual Savings and Compliance Costs**
		7% Discount Rate		**3% Discount Rate**	
Leak Repair					
CC (Sub-small, 15-50 lbs.)	-$36,100	$3,054,000	$3,018,000	$1,450,000	$1,414,000
CC (Small, 51-199 lbs.)	$0	$0	$0	$0	$0
CC (Medium, 200-1,999 lbs.)	-$3,184,000	$8,798,000	$5,614,000	$4,210,000	$1,026,000
CC (Large, ≥2,000 lbs.)	-$120,900	$139,000	$18,000	$66,000	-$55,000
CR (Sub-small, 15-50 lbs.)	-$198,400	$3,748,000	$3,549,000	$1,780,000	$1,582,000
CR (Small, 51-199 lbs.)	-$183,500	$244,000	$60,000	$116,000	-$68,000
CR (Medium, 200-1,999 lbs.)	-$1,945,200	$1,894,000	-$51,000	$905,000	-$1,041,000
CR (Large, ≥2,000 lbs.)	-$1,348,900	$549,000	-$800,000	$259,000	-$1,090,000
IPR (Medium, 200-1,999 lbs.)	-$192,200	$137,000	-$55,000	$66,000	-$126,000
IPR (Large, ≥2,000 lbs.)	-$5,925,600	$734,000	-$5,192,000	$348,000	-$5,577,000
Leak Inspection					

CC (Sub-small, 15-50 lbs.)	$0	$10,012,000	$10,012,000	$10,012,000	$10,012,000
CC (Small, 51-199 lbs.)	$0	$0	$0	$0	$0
CC (Medium, 200-1,999 lbs.)	$0	$11,422,000	$11,422,000	$11,422,000	$11,422,000
CC (Large, ≥2,000 lbs.)	$0	$141,000	$141,000	$141,000	$141,000
CR (Sub-small, 15-50 lbs.)	$0	$24,392,000	$24,392,000	$24,392,000	$24,392,000
CR (Small, 51-199 lbs.)	$0	$1,528,000	$1,528,000	$1,528,000	$1,528,000
CR (Medium, 200-1,999 lbs.)	$0	$11,906,000	$11,906,000	$11,906,000	$11,906,000
CR (Large, ≥2,000 lbs.)	$0	$884,000	$884,000	$884,000	$884,000
IPR (Medium, 200-1,999 lbs.)	$0	$1,379,000	$1,379,000	$1,379,000	$1,379,000
IPR (Large, ≥2,000 lbs.)	$0	$993,000	$993,000	$993,000	$993,000
Automatic Leak Detection					
CC	$0	$0	$0	$0	$0
CR	$0	$130,751,000	$130,751,000	$130,751,000	$130,751,000
IPR	$0	$75,826,000	$75,826,000	$75,826,000	$75,826,000
Reporting & Recordkeeping					
CC and CR (15-50 lbs.)	$0	$6,328,000	$6,328,000	$6,328,000	$6,328,000
CC, CR, and IPR (≥50 lbs.)	$0	$5,459,000	$5,459,000	$5,459,000	$5,459,000
Total	**-$13,134,800**	**$300,320,000**	**$287,180,000**	**$290,220,000**	**$277,090,000**

Totals may not sum due to independent rounding.

More detailed results for reporting and recordkeeping are shown in Table 4-4 below.

Table 4-4. 2025 Incremental Compliance Costs for Recordkeeping and Reporting for Leak Inspection and Leak Repair (2022$)

Recordkeeping & Reporting Rule Component	Direct Compliance Costs		
	CC and CR (15-50 pounds)	CC, CR, and IPR (≥50 pounds)	Total
Recordkeeping associated with leak inspection and repair			
Owners/operators of appliances w/charge sizes ≥15 lbs maintain installation records.	$129,000	$284,000	$413,000
Persons servicing appliances w/charge sizes ≥15 lbs provide invoices to appliance owners/operators.	$1,407,000	$1,173,000	$2,580,000
Owners/operators of appliances w/charge sizes ≥15 lbs maintain purchase and service records.	$1,924,000	$1,604,000	$3,528,000
Persons servicing appliances w/charge sizes ≥15 lbs provide leak inspection records	$185,000	$132,000	$317,000
Owners/operators of appliances w/charge sizes ≥15 lbs maintain leak inspection records	$337,000	$551,000	$888,000
Owners/operators of appliances w/charge sizes ≥15 lbs prepare & submit requests for extensions to 30-day repair timeline	$7,000	$7,000	$14,000

Owners/operators of appliances w/charge sizes ≥15 lbs prepare & submit requests for extensions to 1-year retrofit/repair timeline	$1,000	$1,000	$2,000
Owners/operators of appliances w/charge sizes ≥15 lbs - Develop/Maintain plan to retire/replace or retrofit equipment, as applicable	$1,619,000	$1,154,000	$2,773,000
Owners/operators of HFC appliances to submit requests to cease retrofit/retirement if all leaks are repaired	$5,000	$4,000	$9,000
Owners/operators of appliances w/charge sizes ≥15 lbs maintain records on mothballed equipment	<$200	<$100	<$200
Persons servicing appliances w/charge sizes ≥15 lbs provide reports on the results of verification tests	$185,000	$132,000	$317,000
Owners/operators of appliances w/charge sizes ≥15 lbs - Maintain reports on the results of verification tests	$506,000	$360,000	$866,000
Owners/operators of appliances w/charge sizes ≥15 lbs prepare and submit a report to EPA if excluding purged refrigerants that are destroyed from annual leak rate calculations for the first time	<$100	<$100	<$100
Owners/operators of appliances w/charge sizes ≥15 lbs maintain information on purged/destroyed refrigerant	<$100	<$100	<$100
Owners/operators of appliances submit report to EPA and describe efforts to identify and repair systems that leak 125% or more of the full charge in a 365 day period	$21,000	$15,000	$36,000
Owners/operators maintain records of anything that is reported to EPA.	$1,000	$1,000	$2,000
Owners/operators of direct ALD systems maintain records regarding the annual calibration or audit of the system and any time the ALD system detects a leak[a]	$0	$41,000	$41,000
Total	**$6,328,000**	**$5,459,000**	**$11,790,000**

Totals may not sum due to independent rounding.
[a] The use of direct ALD monitoring is assumed to provide owners/operators with the information needed to satisfy this requirement (i.e., no burden is assumed for those systems assumed to install direct ALD systems).

4.3. Leak Repair and Inspection Emission Reduction Benefits

The Agency's proposed leak repair requirements for refrigerant-containing appliances that contain HFCs or a substitute for HFCs with a GWP greater than 53 are expected to reduce GHG emissions. Annual GHG emissions avoided from the proposed regulations are expected to be approximately 3.8 $MMTCO_2eq$ in 2025 to 1.9 $MMTCO_2eq$ in 2050. **Error! Reference source not found.** below shows the GHG emissions avoided from HFC refrigerants by rule component for selected years.

Table 4-5. Annual GHG Emissions Avoided in 2025, 2030, 2040, and 2050

Rule Component	**GHG Emissions Avoided ($MTCO_2eq$)**			
Leak Repair	**2025**	**2030**	**2040**	**2050**
CC (Sub-small, 15-50 lbs.)	5,900	6,500	7,300	8,000

CC (Small, 51-199 lbs.)	-	-	-	-
CC (Medium, 200-1,999 lbs.)	513,000	480,000	219,000	132,000
CC (Large, ≥2,000 lbs.)	17,900	15,800	12,200	9,300
CR (Sub-small, 15-50 lbs.)	65,000	59,600	45,700	50,400
CR (Small, 51-199 lbs.)	74,700	97,000	124,000	140,000
CR (Medium, 200-1,999 lbs.)	690,000	803,000	970,000	1,080,000
CR (Large, ≥2,000 lbs.)	551,000	527,000	470,000	443,000
IPR (Medium, 200-1,999 lbs.)	36,000	29,900	13,400	-
IPR (Large, ≥2,000 lbs.)	1,850,000	1,770,000	922,000	
Total	**3,800,000**	**3,790,000**	**2,780,000**	**1,860,000**

Totals may not sum due to independent rounding.

4.4. Leak Repair and Inspection Emission Reduction Benefits in Later Years

The distribution of refrigerant-containing appliances that contain HFCs or a substitute for HFCs with a GWP greater than 53 in use is anticipated to change significantly over the next decades, resulting in different leak repair and inspection benefits for later years. Table 4-6**Error! Reference source not found.** below shows the annual GHG emissions avoided from HFC refrigerants. Note that the GWP-weighted emissions avoided in 2050 are less than half that in 2025 not because of decreased efficacy of leak repair or a decrease in use of refrigerant, but because the average GWP of the refrigerant that would leak gets lower over time.

Table 4-6. Annual GHG Emissions Avoided in Select Years

Year	HFC Emissions Avoided ($MTCO_2e$)
2025	3,800,000
2029	3,810,000
2034	3,640,000
2036	3,370,000
2045	2,060,000
2050	1,860,000
Total 2025–2050	**77,800,000**

4.5. Estimated Climate Benefits of Leak Repair

Table 4-7. Monetized Climate Benefits (2022$)

Year	Emissions Avoided ($MTCO_2e$)	Monetized Climate Benefits (3% Discount Rate SC-HFC)
2025	3,800,000	$293,500,000
2026	3,810,000	$302,600,000
2027	3,820,000	$311,200,000
2028	3,820,000	$319,300,000
2029	3,810,000	$326,600,000
2030	3,790,000	$332,900,000

2031	3,780,000	$340,000,000
2032	3,750,000	$345,700,000
2033	3,720,000	$351,800,000
2034	3,640,000	$352,800,000
2035	3,510,000	$347,700,000
2036	3,370,000	$342,200,000
2037	3,230,000	$335,800,000
2038	3,080,000	$328,300,000
2039	2,930,000	$319,800,000
2040	2,780,000	$310,100,000
2041	2,630,000	$299,400,000
2042	2,480,000	$288,300,000
2043	2,330,000	$276,700,000
2044	2,180,000	$264,700,000
2045	2,060,000	$255,600,000
2046	1,970,000	$249,100,000
2047	1,900,000	$245,500,000
2048	1,860,000	$245,000,000
2049	1,850,000	$248,100,000
2050	1,860,000	$255,100,000
	Discount Rate	**3%**
	NPV	$5,359,000,000
	EAV	$291,000,000

4.6. Comparison of Net Benefits for Alternative Leak Repair and Automatic Leak Detection Scenarios

This rule proposes to require appliances with 15 pounds or greater charge size to repair leaks above the leak rate threshold and proposes that all CR and IPR equipment with charge sizes of 1,500 pounds or more of refrigerant be equipped with ALD systems. Charge sizes other than 15 pounds were considered for the leak repair threshold, and a comparison of the net benefits (climate benefits minus compliance costs) in select years for different scenarios are shown in Table 4-8Table 4-8Table 5-1. All of the scenarios in the table assume the charge size threshold for requiring ALD systems is 1,500 lb. More detailed information on the benefits and costs of alternative threshold scenarios can be found in Appendix F.

The incremental effect of lowering the leak repair threshold from 50 lbs. or greater to 30 lbs. or greater decreases the PV of net benefits by $465 million at a 3% discount rate ($258 million at a 7% discount rate). This results because, in the charge size range from 30 lbs to 50 lbs, the compliance costs (net of annual refrigerant savings) exceed the climate benefits. The incremental effect of lowering the leak repair threshold from 30 lbs. or greater to 15 lbs. or greater decreases the PV of net benefits by $269 million at a 3% discount rate ($162 million at 7% discount rate).

Table 4-8. Comparison of Net Benefits for Alternative Leak Repair Thresholds. (Millions 2022$)

Year	**5 lb Leak Repair**		**30 lb Leak Repair**		**50 lb Leak Repair**	
	Emissions Avoided ($MMTCO_2e$)	**Net Benefits (3% Discount Rate SC-HFC)**	**Emissions Avoided ($MMTCO_2e$)**	**Net Benefits (3% Discount Rate SC-HFC)**	**Emissions Avoided ($MMTCO_2e$)**	**Net Benefits (3% Discount Rate SC-HFC)**
2025	4.2	-$383	3.8	$30	3.7	$55
2029	4.2	-$346	3.8	$92	3.7	$118
2034	4.0	-$289	3.6	$174	3.6	$200
2036	3.7	-$313	3.4	$163	3.3	$189
2045	2.4	-$454	2.1	$70	2.0	$98
2050	2.2	-$478	1.9	$64	1.8	$92
Total	86		78		76	
Costs d.r.	**3%**	**7%**	**3%**	**7%**	**3%**	**7%**
NPV (2025–2050)	-$6,243	-$1,734	$1,992	$3,168	$2,457	$3,426
EAV	-$339	-$284	$108	$118	$133	$141

Totals may not sum due to independent rounding.

EPA also considered various charge size thresholds for the proposed provision requiring the use of ALD equipment. The net benefits of scenarios with ALD required at 500 lb., 1,000 lb., and 2,000 lb. are shown in Table 4-9. All scenarios in the table assume a leak repair charge size threshold of 15 pounds.

The incremental effect of upping the ALD threshold from 1500 lbs or greater to 2000 lbs or greater increases the PV of net benefits by $629 million at a 3 percent discount rate ($337 million at a 7 percent discount rate). The incremental effect of lowering the ALD threshold from 1500 lbs to 1000 lbs decreases the PV of net benefits by $64 million at a 3 percent discount rate ($47 million at a 7 percent discount rate). The incremental effect of lowering the ALD threshold from 1000 lbs to 500 lbs decreases the PV of net benefits by $430 million at a 3 percent discount rate ($100 million at 7 percent discount rate).

Table 4-9. Comparison of Net Benefits for Alternative ALD Thresholds (Millions of 2022$)

Year	**500 lb**		**1,000 lb ALD**		**2,000 lb ALD**	
	Emissions Avoided ($MMTCO_2e$)	***Net Benefits (3% Discount Rate SC-HFC)***	***Emissions Avoided ($MMTCO_2e$)***	***Net Benefits (3% Discount Rate SC-HFC)***	***Emissions Avoided ($MMTCO_2e$)***	***Net Benefits (3% Discount Rate SC-HFC)***

2025	4.0	-$50	3.8	-$1	3.7	$70
2029	4.1	$20	3.8	$67	3.7	$126
2034	3.9	$135	3.7	$157	3.5	$192
2036	3.7	$125	3.4	$146	3.3	$180
2045	2.4	$39	2.1	$53	2.0	$86
2050	2.2	$36	1.9	$46	1.7	$79
Total	85		78		75	
Costs d.r.	**3%**	**7%**	**3%**	**7%**	**3%**	**7%**
NPV (2025–2050)	$1,228	$2,859	$1,659	$2,958	$2,352	$3,342
EAV	$67	$81	$90	$101	$128	$136

Totals may not sum due to independent rounding.

5. Comparison of Costs and Benefits for the Proposed Rule

5.1. Comparison of Costs and Benefits of Leak Repair and Inspection Provisions

As shown in Table 5-1, it is estimated that the economic benefits of avoiding millions of tons of potent GHGs would far outweigh the costs of complying with the proposed Leak Repair and ALD provisions of this rule. Over the period 2025–2050, the equivalent annual benefits associated with reduced climate damages are approximately $291 million (3 percent discount rate), while the estimated EAV of compliance costs is $186M (7 percent) to $197M (3 percent). Thus, it is estimated that this rule as proposed would generate net benefits with a present value of $1.7B to $3.0B from 2025–2050, equivalent to annual net benefits of $94M to $105M.

Table 5-1. Monetized Climate Benefits, Costs, and Net Benefits for Leak-related Provisions

Year	Climate Benefits	Cost	Net Benefits
2025	$293,500,000	$265,300,000	$28,200,000
2026	$302,600,000	$205,800,000	$96,800,000
2027	$311,200,000	$216,300,000	$94,900,000
2028	$319,300,000	$228,900,000	$90,400,000
2029	$326,600,000	$236,100,000	$90,500,000
2030	$332,900,000	$176,700,000	$156,200,000

2031	$340,000,000	$177,900,000		$162,100,000	
2032	$345,700,000	$178,700,000		$167,000,000	
2033	$351,800,000	$179,600,000		$172,200,000	
2034	$352,800,000	$180,400,000		$172,400,000	
2035	$347,700,000	$180,800,000		$166,900,000	
2036	$342,200,000	$181,200,000		$161,000,000	
2037	$335,800,000	$182,100,000		$153,700,000	
2038	$328,300,000	$182,800,000		$145,500,000	
2039	$319,800,000	$183,600,000		$136,200,000	
2040	$310,100,000	$184,300,000		$125,800,000	
2041	$299,400,000	$184,900,000		$114,500,000	
2042	$288,300,000	$185,500,000		$102,800,000	
2043	$276,700,000	$186,100,000		$90,600,000	
2044	$264,700,000	$186,600,000		$78,100,000	
2045	$255,600,000	$187,300,000		$68,300,000	
2046	$249,100,000	$188,100,000		$61,000,000	
2047	$245,500,000	$189,000,000		$56,500,000	
2048	$245,000,000	$190,200,000		$54,800,000	
2049	$248,100,000	$191,500,000		$56,600,000	
2050	$255,100,000	$193,100,000		$62,000,000	
DR	**3%**	**3%**	**7%**	**3%**	**7%**
PV	**$5,359,000,000**	**$3,395,000,000**	**$2,203,000,000**	**$1,964,000,000**	**$3,156,000,000**
EAV	**$291,000,000**	**$196,000,000**	**$199,000,000**	**$95,000,000**	**$92,000,000**

Totals may not sum due to independent rounding.

5.2 Comparison of Costs and Benefits of Required Use of Reclaimed HFCs

The use of some recycled/reclaimed HFCs was already anticipated as a path to compliance with the HFC phasedown consumption caps in the analysis of the Allocation Framework rule and 2024 Allocation Rule RIA Addendum, but the specific provisions of this proposed rule would increase the use of recycled/reclaimed HFCs beyond what was already accounted for in that RIA.

Because the cost savings estimated in Appendix B using the methods in Yasaka et al. are based on the life cycle differences between the use of reclaimed refrigerant and using virgin refrigerant, under the base case scenario where the allocations not used by the subsectors required to use reclaimed refrigerant are instead transferred and used by others, no incremental benefits are estimated. Under the high-additionality case, the required use of reclaim is estimated to generate incremental climate benefits of $267 M from 2028 through 2050, discounted to 2024 at 3 percent. The estimated net benefits of the provisions requiring use of reclaimed refrigerant are $251 M discounting costs at 3 percent and $256 M discounting costs at 7 percent. Details of monetized climate benefits, compliance costs, and net benefits are provided in Table 5-2.

Table 5-2. Monetized Climate Benefits, Costs, and Net Benefits for Required Use of Reclaim (millions of 2022$)

Year	Climate Benefits	Cost		Net Benefits	
2025	$0	$0		$0	
2029	$9.9	$1.0		$8.9	
2034	$21.8	$1.1		$20.7	
2036	$22.0	$1.1		$20.9	
2045	$19.9	$0.9		$19.0	
2050	$15.0	$0.9		$14.1	
DR	**3%**	**3%**	**7%**	**3%**	**7%**
PV	**$267**	**$16**	**$11**	**$251**	**$256**
EAV	**$14**	**$1**	**$1**	**$14**	**$14**

Totals may not sum due to independent rounding.

5.3 Comparison of Costs and Benefits of Requirements on HFC Cylinders

As detailed in Appendix C, the proposed provisions requiring management and tracking of cylinders of refrigerants and fire suppressants would entail compliance costs and climate benefits. Under both the base case and high additionality case, it is estimated that the provisions of this proposed rule would generate additional net benefits of approximately $4.5 billion over the period 2025 through 2050, discounted to 2024.

5.4 Comparison of Costs and Benefits of Fire Suppression Sector Provisions

As detailed in Appendix D, the provisions for the fire suppression sector proposed in this rule are not estimated to have any incremental benefits under the Base Case. In the High-additionality case, we estimate the provisions would yield an average of 0.96 $MMTCO_2e$ annually in avoided HFC consumption. When converted to corresponding emissions reductions over equipment lifetime and monetized using the social cost of HFCs, the present value of cumulative climate benefits over the 2025–2050 period is estimated to be $342 million in the high additionality case. These potential benefits, along with estimated costs from recordkeeping and reporting provisions, are shown in Table 5-3 below.

Table 5-3. Monetized Climate Benefits, Costs, and Net Benefits for Fire Suppression Sector Provisions Under High Additionality Scenario (millions of 2022$)

Year	Climate Benefits	Cost		Net Benefits	
2025	$19.0	$0.3		$18.7	
2029	$20.1	$0.3		$19.7	
2034	$21.9	$0.3		$21.6	
2036	$22.0	$0.3		$21.7	
2045	$19.9	$0.3		$19.6	
2050	$15.0	$0.3		$14.7	
DR	**3%**	**3%**	**7%**	**3%**	**7%**
PV	**$342**	**$5.0**	**$3.2**	**$337**	**$338**
EAV	**$19**	**$0.3**	**$0.3**	**$18**	**$18**

Totals may not sum due to independent rounding.

5.5 Comparison of Costs and Benefits of RCRA Amendments

As described in Section 3.4, the amendments to RCRA standards for reclaimers are anticipated to be cost neutral or to provide some savings from reduced compliance burden on these entities. As documented in the ICR in the docket for this rulemaking, the aggregate annual reduction in compliance burden of approximately $91,000. Taking this value as the net benefit of the amendments for each year 2025 through 2050 and discounting the savings to 2024, the present value of the savings benefits would be $1.0 million (7 percent discount rate) to $1.6 million (3 percent). This would be equivalent to $0.1 M annually 2025–2050. Because these benefits are not related to HFC consumption that was already accounted for under the Allocation Framework rule, the net benefits would be the same under the base case and the high additionality case. Because these estimates are heavily dependent on the future market for ignitable spent refrigerant sent for reclamation, which is difficult to predict with currently available data, the net benefits may be lower and are shown as a range from $0 to the discounted values above. These net benefits are not added to the overall incremental benefits of the proposed rule in Table 5-5**Error! Reference source not found.**.

5.6 Recordkeeping and Reporting Costs

The subsection (h) rule contains several provisions that EPA has estimated will result in additional recordkeeping and reporting cost burden for affected industries.

EPA has prepared an information collection request (ICR), ICR Number 2778.01, and a Supporting Statement which can be found in the docket. The information collection requirements for recordkeeping, reporting, and labeling are not enforceable until OMB approves them. Among other things, EPA calculated the estimated time and financial burden over a three-year period (ICRs generally cover three-year time periods) for respondents to implement labeling practices and to electronically report data to the Agency on an annual basis. A key summary of the respondent burden estimates follows, and the full methodology for these calculations can be found in the docket.

Recordkeeping and reporting costs associated with the rule's proposed leak repair and inspection requirements, fire suppression equipment requirements, cylinder tracking requirements, and reclamation requirements are summarized in table 24 below. Based on these estimates, the present value (discounted to 2024) of total recordkeeping and reporting costs across all proposed rule provisions is approximately $307 million, using a 3% discount rate, or $199 million, using a 7% discount rate.

Table 5-4: Estimated Recordkeeping and Reporting Costs by Rule Provision (millions 2022$)

Year	Leak Inspection and Repair		Fire Suppression		Cylinder Tracking		Reclamation	
2025	$11.79		$0.05		$1.05		$0.01	
2030	$13.34		$0.05		$3.25		$0.06	
2035	$13.86		$0.05		$3.25		$0.06	
2040	$14.51		$0.05		$3.25		$0.06	
2045	$15.14		$0.05		$3.25		$0.06	
2050	$15.76		$0.05		$3.25		$0.06	
DR	**3%**	**7%**	**3%**	**7%**	**3%**	**7%**	**3%**	**7%**
PV	$241.44	$150.62	$0.82	$0.52	$54.54	$34.17	$0.99	$0.62
EAV	$13.91	$13.63	$0.05	$0.05	$3.14	$3.09	$0.06	$0.06

5.7 Comparison of Costs and Benefits of the Proposed Rule

The present value of the net benefits of this proposed rule are equal to the sum of the net costs or benefits of the various provisions in each year 2025–2050, discounted to 2024. The proposed provisions which contribute to the total net benefits are those covering leak inspections, leak repair, recordkeeping and reporting, reduced emissions and use of recycled HFCs in fire suppression equipment management and ultimate evacuation of disposable cylinders and tracking provisions for disposable and refillable cylinders, and the required use of reclaimed HFCs in the initial charging and service of certain appliances. The use of recycled/reclaimed HFCs was already anticipated as a path to compliance with the HFC phasedown consumption caps in the analysis of the Allocation Framework rule, but the specific provisions of this proposed rule would likely increase the use of recycled/reclaimed HFCs beyond what was already accounted for in that RIA. To the extent this additional use of recycled/reclaimed HFCs displaces consumption of virgin HFCs either a) the reduced consumption of virgin HFCs in one sector would free up allocation allowances that would then be used elsewhere for consumption of HFCs, or b) the reduction in the consumption of virgin HFCs would result in incremental climate benefits under this proposed rule. The former scenario is presented as part of the base case and the latter as part of the high additionality case for the net benefits in Table 5-5.

Table 5-5: Present Value and Equivalent Annual Value of the Net Benefits or Costs of Rule Provisions 2025–2050[a,b]

		Base Case Net Benefits 2025–2050 (millions 2022$)		**High Additionality Case Net Benefits 2025–2050 (millions 2022$)**	
Rule Provisions	**Costs Discount Rate**	**3%**	**7%**	**3%**	**7%**
Leak Repair, Leak Inspection,& ALD	NPV	$1,964	$3,156	$1,964	$3,156
	EAV	$113	$109	$113	$109
Fire Suppression	NPV	$0	$0	$337	$338
	EAV	$0	$0	$18	$18
Cylinder Management	NPV	$4,453	$4,457	$4,453	$4,457
	EAV	$257	$256	$257	$256
Required Use of Reclaim	NPV	$0	$0	$251	$256
	EAV	$0	$0	$14	$14
Recordkeeping and Reporting	NPV	($298)	($186)	($298)	($186)
	EAV	($17)	($17)	($17)	($17)
Total (AIM Act)	NPV	$6,120	$7,427	$6,708	$8,021
	EAV	$353	$349	$385	$381
RCRA Amendments	NPV	$0–$1.6	$0–$1.0	$0–$1.6	$0–$1.0
	EAV	$0–$0.1	$0–$0.1	$0–$0.1	$0–$0.1
Total (AIM + RCRA)	NPV	$6,120-$6,122	$7,427-$7,428	$6,708-$6,710	$8,021-$8,022
	EAV	$353-$353	$349-$349	$385-$385	$381-$381

a. Net costs are shown in parentheses.
b. Totals may not sum due to independent rounding.

6 Environmental Justice

6.1 Introduction and Background

The environmental justice analyses that were conducted as part of the Allocation Framework Rule RIA and subsequent 2024 Allocation Framework Rule and proposed Technology Transitions Rule RIA addenda addressed issues associated with the impacts of changes in the production of HFCs and certain substitutes of HFCs on communities near facilities identified as producers of these chemicals. EPA could not identify specific effects of the HFC phasedown or transitions on individual communities, but the Agency did identify ten specific facilities with emissions likely to be affected by these rules. EPA analyzed the demographic characteristics of the fence-line communities in the Census Block Groups within 1-, 3-, 5-, and 10-mile radii of the affected facilities. Please refer to Chapter 6 of the Allocation Framework Rule RIA for an extensive discussion of the environmental justice implications of HFC production and transition.

This chapter provides an analysis of the environmental justice (EJ) implications of this proposed rule under Subsection (h) of the AIM Act. The information provided in this section of this document is for informational purposes only; EPA is not relying on the information in this section as a record basis for the proposed action. This analysis is largely similar in approach to that used in the previous EJ analyses, in that it focuses on the baseline environmental conditions in communities proximate to known HFC reclamation facilities which EPA expects may be affected by the proposed Rule.

As discussed in the preamble to this rule, the Subsection (h) Rule proposes to: establish a program for the management of hydrofluorocarbons that includes requirements for leak repair and use of automatic leak detectors for certain equipment containing HFC refrigerants; require use of reclaimed HFCs in certain sectors or subsectors; establish management, labeling and tracking standards for disposable and refillable cylinders; mandate certain recordkeeping and reporting requirements; and require certain other elements related to the effective implementation of the Act. EPA is also proposing alternative Resource Conservation and Recovery Act (RCRA) standards for ignitable, spent refrigerants being recycled for reuse. The new standards would require that ignitable, spent refrigerant being recycled for reuse be sent to EPA-certified reclamation facilities.

6.2 Environmental Justice at EPA

Executive Order 12898 (59 FR 7629; February 16, 1994) and Executive Order 14008 (86 FR 7619, January 27, 2021) establish federal executive policy on environmental justice. Executive Order 12898's main provision directs federal agencies, to the greatest extent practicable and permitted by law, to make environmental justice part of their mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on people of color and low-income populations in the United States. EPA defines environmental justice as the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.35 Executive Order 14008 (86 FR 7619; January 27, 2021) also calls on Agencies to make achieving environmental justice part of their missions "by developing programs, policies, and activities to address the disproportionately high and adverse human health, environmental, climate-related and other cumulative impacts on disadvantaged communities, as well as the accompanying economic challenges of such impacts." It also declares a policy "to secure environmental justice and spur economic opportunity for disadvantaged communities that have been historically marginalized and overburdened by pollution and under-investment in housing, transportation, water and wastewater infrastructure and health care." EPA also released its "Technical Guidance for

[35] Fair treatment occurs when "no group of people should bear a disproportionate burden of environmental harms and risks, including those resulting from the negative environmental consequences of industrial, governmental, and commercial operations or programs and policies" (U.S. EPA, 2011). Meaningful involvement occurs when "1) potentially affected populations have an appropriate opportunity to participate in decisions about a proposed activity [i.e., rulemaking] that will affect their environment and/or health; 2) the population's contribution can influence [the EPA's] rulemaking decisions; 3) the concerns of all participants involved will be considered in the decision-making process; and 4) [the EPA will] seek out and facilitate the involvement of population's potentially affected by EPA's rulemaking process" (U.S. EPA, 2015). A potential environmental justice concern is defined as "actual or potential lack of fair treatment or meaningful involvement of minority populations, low-income populations, tribes, and indigenous peoples in the development, implementation and enforcement of environmental laws, regulations and policies" (U.S. EPA, 2015). See also https://www.epa.gov/environmentaljustice.

Assessing Environmental Justice in Regulatory Analysis" (U.S. EPA, 2016) to provide recommendations that encourage analysts to conduct the highest quality analysis feasible, recognizing that data limitations, time and resource constraints, and analytic challenges will vary by media and circumstance.

As noted in the Allocation Framework Rule RIA, the production and consumption of HFCs is expected to result in changes in the emissions of chemicals which burden communities surrounding HFC production facilities. Because of the limited information regarding how much of each substitute would be produced, which substitutes would be used, and what other factors might affect production and emissions at those locations, it's unclear to what extent baseline risks from hazardous air toxics for communities living near HFC production facilities may be affected. We do understand that communities neighboring facilities that currently produce HFCs and those that are likely to produce HFC alternatives are often overburdened and disadvantaged. The Agency has a strong interest in mitigating undue burden on underserved communities.

EPA stated its intention in the Allocation Framework Rule to "continue to monitor the impacts of this program on HFC and substitute production, and emissions in neighboring communities, as we move forward to implement this rule" (see 86 FR 55129). EPA will continue to work to address environmental justice and equity concerns for the communities near the facilities identified in this analysis.

6.3 Environmental Justice Analysis for this Rule

In the Allocation Framework Rule, EPA summarized the public health and welfare effects of GHG emissions (including HFCs), including findings that certain parts of the population may be especially vulnerable to climate change risks based on their characteristics or circumstances, including the poor, the elderly, the very young, those already in poor health, the disabled, those living alone, and/or indigenous populations dependent on one or limited resources due to factors including but not limited to geography, access, and mobility (86 FR 55124 - 55125). Potential impacts of climate change raise environmental justice issues. Low-income communities can be especially vulnerable to climate change impacts because they tend to have more limited capacity to bear the costs of adaptation and are more dependent on climate-sensitive resources such as local water and food supplies. In corollary, some communities of color, specifically populations defined jointly by both ethnic/racial characteristics and geographic location, may be uniquely vulnerable to climate change health impacts in the United States.

As discussed in more detail in the RIA for the Allocation Framework Rule, the environmental justice benefits of reducing climate change are significant. The proposed Subsection (h) rule is expected to result in benefits in the form of reduced GHG emissions, including by reducing the rates of leakage of HFCs to the atmosphere from new and existing equipment. The analysis conducted for this rule also estimates that a portion of these benefits would be incremental to emissions reductions that were anticipated under the Allocation Framework Rule alone, thus further reducing the risks of climate change.

HFCs are not a local pollutant and have low toxicity to humans. The Proposed Rule is expected to result in increased activity at HFC recovery and reclamation facilities. EPA does not anticipate that there are significant increased risks to human health in communities near these facilities due to the presence or potential leakage of the HFCs themselves. It is possible that other chemicals which are potential byproducts of HFC reclamation processes, such as petroleum-based lubricants and waste oils, may be released from these facilities. In addition, the RCRA provisions would allow lower flammability spent refrigerants to be sent to HFC recovery and reclamation facilities, potential increasing the potential for fires at the facilities. To help address the risks posed by fires, the proposed standards include emergency preparedness and response requirements.

For the purposes of this rule, EPA assessed the characteristics of communities near facilities we expect to be affected by this rule (i.e., HFC reclamation facilities). EPA used data from reports required under Section 608 of the Clean Air Act,[36] EPA's ECHO database[37] and information provided by company websites to identify facilities that are active HFC reclaimers. Once reclaim facility locations were identified, EPA retrieved the Facility Registry Service (FRS) IDs for each facility using the Agency's FRS national dataset.[38] EPA derived additional information on the communities surround the facilities included this analysis using data from AirToxScreen 2019 (EPA 2023b) and the Census' American Community Survey 2019 (U.S. Census Bureau 2021). These steps were conducted to facilitate extracting 1) an environmental profile and 2) demographic information within 1, 3, 5 and 10 miles for each facility.

Fenceline communities may be impacted by emissions or chemical releases from facilities of the type identified here, although there is uncertainty about the nature and risks of potential emissions or chemical releases. This analysis notes several limits to our ability to assess the impact this rule on the exposure that specific communities may face:

- The facilities that we identified are diverse, ranging in size from small, boutique facilities that recover and reclaim HFCs for small market to large chemical production facilities that have several lines of business that may result in atmospheric emissions. EPA does not have information that allows us to distinguish possible fugitive emissions from HFC reclamation and other potential chemical processing or manufacture.

[36] EPA reviewed Section 608 annual reclamation reports to determine facilities that currently reclaim HFCs and may therefore be expected to continue to do so in the future.
[37] EPA's Enforcement and Compliance History Online (ECHO) database was used to verify locations of HFC reclamation facilities
[38] FRS National Data Set available at https://www.epa.gov/frs/epa-frs-facilities-state-single-file-csv-download

- Many of the communities near the facilities expected to be affected by this rule are also near other sources of toxic emissions which contribute to environmental justice concerns.
- The proposed rule, and other changes in the HFC reclamation market, would likely result in an overall increase in reclamation, but may result in increases or decreases in the activity at any given facility, or the construction of additional facilities.
- In regard to the effect of the proposed RCRA alternative standards on flammable refrigerants, any potential increase in volumes sent to reclamation facilities would likely be offset by a decrease in volume sent to incineration facilities, or vented illegally.

Due to the limitations of the current data, we cannot make conclusions about the impact of this rule on individuals or specific communities. For the purposes of identifying environmental justice issues, however, it is important to understand the characteristics of the communities surrounding these facilities to better ensure that future actions, as more information becomes available, can improve outcomes. Following the format used for the Allocation Framework Rule RIA, this analysis focuses on information that is available on the demographics and baseline exposure of the communities near these facilities.

6.4 Aggregate Average Characteristics of Communities Near Potentially Affected Production Facilities

The RIA for the Allocation Framework Rule notes that a key issue for evaluating potential for environmental justice concerns is the extent to which an individual might be exposed to feedstock, catalyst, or byproduct emissions from production of HFCs or HFC alternatives. This proposed rule may result in increases in the numbers of individuals exposed to chemicals in the process of reclaiming and recycling HFCs.

EPA has not undertaken an analysis of how potential emissions from HFC reclamation affect nearby communities. However, a proximity-based approach can identify correlations between the location of these identified reclamation facilities and potential effects on nearby communities. Specifically, this approach assumes that individuals living within a specific distance of an HFC reclamation facility are more likely to be exposed to releases the reclamation process. Those living further away are less likely to be exposed to these releases. Census block groups that are located within 1, 3, 5 and 10 miles of the facility are selected as potentially relevant distances to proxy for exposure. Socioeconomic and demographic data from the American Community Survey 5-year data release for 2019 is used to examine whether a greater percentage of population groups of concern live within a specific distance from a production facility compared to the national average. The national average for rural areas is also presented since four of the nine production facilities expected to be impacted by this rule are classified as rural.39

In addition, AirToxScreen data from 2019 for census tracts within and outside of a 1-, 3-, 5- and 10-mile distance are used to approximate the cumulative baseline cancer and respiratory risk due to air toxics exposure for communities near these production facilities. The total cancer risk is reported as the risk per million people if exposed continuously to the specific concentration over an assumed lifetime. The total respiratory risk is reported as a hazard quotient, which is the exposure to a substance divided by the level at which no adverse effects are expected. Both total risk measures are the sum of the individual risk values for all the chemicals evaluated in the AirToxScreen database (EPA 2023b). Note that these risks are not necessarily only associated with a specific HFC production facility. Industrial activity is often concentrated (i.e., multiple plants located within the same geographic area).

Table 6-1 presents summary information for the demographic data and AirToxScreen risks averaged across the nineteen communities near the identified production facilities compared to the overall national average.

The values in the last four columns reflect population-weighted averages across the Census block groups within the specified distance of the facility. While it is not possible to disaggregate the risk information from AirToxScreen by race, ethnicity or income, the overall cancer and respiratory risk in communities within 1, 3, 5 or 10 miles of an identified production facility is does not appear to be markedly greater than either the overall or rural national average.

Table 6-1: Overall Community Profile and 2019 AirToxScreen Risks for Communities Near Identified Facilities

	Overall National Average	***Within 1 mile of production facility***	***Within 3 miles of production facility***	***Within 5 miles of production facility***	***Within 10 miles of production facility***
% White (race)	*72*	*67*	*62*	*60*	*60*

[39] The US Census definition of "rural" is used. The term rural is applied to census areas that are not classified as urbanized areas or urban clusters and have a population density below 2,500 people per square mile. Census also looks at other factors before classifying an area as rural including adjacency to an urban area. For the 1-mile radius, population density near an HFC production facility ranges from 40 people per square mile to 306 people per square mile for each of the seven facilities in rural areas. For the 3-mile radius, population density near a facility ranges from 46 people per square mile to 1,262 people per square mile. However, if the majority of census blocks within our buffer are urban-adjacent, we continue to use the overall national or state level average as a basis of comparison (U.S. Census Bureau 2021).

% Black or African American (race)	*13*	*12*	*15*	*17*	*18*
% Other (race)	*15*	*21*	*23*	*24*	*22*
% Hispanic (ethnic origin)	*18*	*31*	*34*	*30*	*24*
Median Household Income (1k 2019$)	*71*	*77*	*74*	*72*	*75*
% Below Poverty Line	*7.3*	*7.6*	*8.6*	*8.4*	*7.4*
% Below Half the Poverty Line	*5.8*	*5.9*	*6.2*	*6.6*	*6.1*
Total Cancer Risk (per million)	*26*	*25*	*26*	*27*	*27*
Total Respiratory Risk (hazard quotient)	*0.31*	*0.32*	*0.33*	*0.33*	*0.34*

Notes: Demographic definitions are as described in the 2019 American Community Survey (U.S. Census Bureau 2021). The "hazard quotient" is defined as the ratio of the potential exposure to a substance and the level at which no adverse effects are expected (calculated as the exposure divided by the appropriate chronic or acute value). A hazard quotient of 1 or lower means adverse noncancer effects are unlikely and, thus, can be considered to have negligible hazard. For HQs greater than one, the potential for adverse effects increases, but we do not know by how much. Total cancer and respiratory risk are drawn from the AirToxScreen database (2019) (EPA 2023b).

Looking across the nineteen facilities (Table 6-1), a higher percentage of non-white individuals live in the communities near HFC reclamation facilities compared to the national average. Within one mile of the facilities, the percentage of Black or African Americans slightly lower than the national average, (12 percent compared to 13 percent) but the percentage increases to 15 percent, 17 percent and 18 percent for the 3 miles, 5 miles, and ten miles, respectively. For the communities near these facilities, there are more whose race is identified as "other," and whose ethnicity is "Hispanic" than the national average. In these communities, the percentage of White residents is higher within one mile of the facilities than farther away. Within one mile, 67 percent of the residents are white, which is lower than the national average of 72 percent.

Median income is generally higher for the communities near these facilities compared to the national average, with the highest median income within the 1-mile radius ($77,000 per year, compared to the national average of $71,000). However, these communities generally have higher percentages of low-income households (below the poverty line) and very low-income households (with incomes less than half the poverty line). The national percentage of households with incomes less than half of the poverty line is 5.8%. Within 1 mile of these specific facilities, the average percentage of households with incomes less than half of the poverty line 5.9 percent. At the 3- and 5-mile distances, the number rises to 6.2 percent and 6.6 percent—it is 6.1 percent in the average 10-mile radius.

For this analysis, we use the most recent 2019 AirToxScreen data for total cancer risk and total respiratory risk. The overall national average total cancer risk using the newest data 26 per million. The Total Respiratory Index average for the nation as a whole is 0.31. The average aggregate risks in communities near these facilities are generally higher than the national averages. The analysis shows, however, that Total Cancer Risk is lower for those within the 1-mile average radius and increase at the 3-, 5-, and 10-mile radii. While the Total Respiratory index for communities within one mile of these nineteen facilities (.32 compared to the national average of .31) the risk for those closest to the facilities appears smaller than for those at greater distances. The analysis shows that 3-mile, 5-mile, and 10-mile Total Respiratory Risk averages are 0.33, 0.33, and 0.34 respectively.

6.5 Previous Violation and Enforcement Actions

Table 6-2 below provides summary data for facilities identified in the above analysis that are currently registered with one or more EPA compliance regimes under major statutes including CAA, RCRA, and the Clean Water Act (CWA). The table also provides a count of the number of facilities identified within a Native American tribal boundary or located within Census block groups in the 80th or higher national percentile of one of the primary EJ indexes of EJSCREEN, EPA's screening tool for EJ concerns. These data were obtained from EPA's Enforcement and Compliance History Online (ECHO). Notably, of the 19 facilities included in the above analysis, 12 are currently registered under CAA, RCRA, NPDES, and/or CWA compliance regimes.

Table 6-2: Number of facilities falling under one or more environmental compliance regime

Variable	***Description of Variable***	***Count of Identified HFC Reclaim Facilities***
AIR_FLAG	*Facility has an Air Facility System (AFS) ID*	*2*
NPDES_FLAG	*Facility has a Clean Water Act NPDES ID*	*4*
SDWIS_FLAG	*Facility has a Safe Drinking Water Information System (SDWIS) ID*	*0*
RCRA_FLAG	*Facility has a Resource Conservation and Recovery Act Information System (RCRAInfo) ID*	*8*
TRI_FLAG	*Facility has a Toxics Release Inventory (TRI) ID (most recent reporting year)*	*1*
GHG_FLAG	*Facility has a Greenhouse Gas (E-GGRT) ID*	*0*
FAC_INDIAN_CNTRY_FLG	*FRS Tribal Code Flag - a Y/N flag indicating whether or not an associated EPA program reported the facility as being within a Native American tribal boundary.*	*0*
FAC_MAJOR_FLAG	*Determines if the facility is a designated as a major.*	*0*
FAC_ACTIVE_FLAG	*A Y/N flag indicating if any of the associated ICIS-Air, ICIS-NPDES, RCRA or SDWA permits are in an active status.*	*12*

EJSCREEN_FLAG_US	*Indicates facilities located in Census block groups in the 80th or higher national percentile of one of the primary environmental justice (EJ) indexes of EJSCREEN, EPA's screening tool for EJ concerns.*	*4*

Source: EPA's Enforcement and Compliance History Online (ECHO). Note: While EPA places a high priority on ensuring the integrity of the national enforcement and compliance databases, some incorrect data may be present due to the large amount of information compiled across multiple streams of data from state, local, and tribal agencies. Known data quality problems are discussed at https://echo.epa.gov/resources/echo-data/known-data-problems

Tables Table 6-3Table 6-4Table 6-5 below provide further information on formal and informal enforcement actions which have occurred at identified facilities within the last 5 years. Out of the 12 facilities, four are registered under CWA, eight under RCRA, and two under CAA. Two facilities have recent CWA enforcement violations, as shown in Table 6-3. None of the identified facilities have recent RCRA or CAA enforcement violations.

Table 6-3: Clean Water Act Compliance Status and Recent Enforcement History by Facility

Facility Name	***CWA NPDES Registration***	***CWA Compliance Status***	***Informal Enforcement Actions (last 5 years)***	***Formal Enforcement Actions (last 5 years)***
CERTIFIED REFRIGERANT SERVICES INC	*N*			
NEWCOMB MECHANICAL INC	*N*			
RECLAIM PA N DELAWARE AVE FAC	*Y*	*Failure to Report DMR - Not Received*	*4*	*3*
ACS RECLAMATION & RECOVERY INC	*N*			
REFRIGERANT HANDLING INC	*N*			
C & M ENTERPRISE OF CHRISTMAS FLORIDA	*N*			
TRADEWATER ELK GROVE VILLAGE	*N*			
PERFECT SCORE TOO, LTD	*Y*	*No Violation Identified*	*0*	*0*
A-GAS US	*Y*	*No Violation Identified*	*0*	*0*
NATIONAL REFRIGERANTS INC	*Y*	*Violation Identified*	*0*	*0*
HUDSON TECHNOLOGIES CO	*N*			
GOLDEN REFRIGERANT	*N*			

Source: EPA's Enforcement and Compliance History Online (ECHO). Note: While EPA places a high priority on ensuring the integrity of the national enforcement and compliance databases, some incorrect data may be present due to the large amount of information compiled across multiple streams of data from state, local, and tribal agencies. Known data quality problems are discussed at https://echo.epa.gov/resources/echo-data/known-data-problems

Table 6-4: Resource Recovery and Conservation Act (RCRA) Compliance Status and Recent Enforcement History by Facility

Facility Name	RCRA Registration	RCRA Compliance Status
CERTIFIED REFRIGERANT SERVICES INC	Y	No Violation Identified
NEWCOMB MECHANICAL INC	Y	No Violation Identified
RECLAIM PA N DELAWARE AVE FAC	Y	No Violation Identified
ACS RECLAMATION & RECOVERY INC	Y	No Violation Identified
REFRIGERANT HANDLING INC	Y	No Violation Identified
C & M ENTERPRISE OF CHRISTMAS FLORIDA	Y	No Violation Identified
TRADEWATER ELK GROVE VILLAGE	Y	No Violation Identified
PERFECT SCORE TOO, LTD	N	
A-GAS US	N	
NATIONAL REFRIGERANTS INC	N	
HUDSON TECHNOLOGIES CO	Y	No Violation Identified
GOLDEN REFRIGERANT	N	

Source: EPA's Enforcement and Compliance History Online (ECHO). Note: While EPA places a high priority on ensuring the integrity of the national enforcement and compliance databases, some incorrect data may be present due to the large amount of information compiled across multiple streams of data from state, local, and tribal agencies. Known data quality problems are discussed at https://echo.epa.gov/resources/echo-data/known-data-problems

Table 6-5: Clean Air Act (CAA) Compliance Status and Recent Enforcement History by Facility

Facility Name	CAA Air Facility System (AFS) Registration	CAA Compliance Status
CERTIFIED REFRIGERANT SERVICES INC	N	
NEWCOMB MECHANICAL INC	N	
RECLAIM PA N DELAWARE AVE FAC	N	
ACS RECLAMATION & RECOVERY INC	N	
REFRIGERANT HANDLING INC	N	
C & M ENTERPRISE OF CHRISTMAS FLORIDA	N	

TRADEWATER ELK GROVE VILLAGE	*N*	
PERFECT SCORE TOO, LTD	*N*	
A-GAS US	*N*	
NATIONAL REFRIGERANTS INC	*N*	
HUDSON TECHNOLOGIES CO	*Y*	*No Violation Identified*
GOLDEN REFRIGERANT	*Y*	*No Violation Identified*

Source: EPA's Enforcement and Compliance History Online (ECHO). Note: While EPA places a high priority on ensuring the integrity of the national enforcement and compliance databases, some incorrect data may be present due to the large amount of information compiled across multiple streams of data from state, local, and tribal agencies. Known data quality problems are discussed at https://echo.epa.gov/resources/echo-data/known-data-problems

6.6 Conclusion

The provisions in this proposed rule are expected to result in benefits in the form of reduced GHG emissions. The analysis conducted for this proposed rule also estimates that a portion of these benefits would be incremental to emissions reductions that were anticipated under the Allocation Framework Rule and 2024 Allocation Framework Rule RIA addendum, thus further reducing the risks of climate change.

While providing additional overall climate benefits, this rule may also result in changes in emissions of air pollutants or other chemicals which are potential byproducts of HFC reclamation processes at affected facilities. The market for reclaimed HFCs could drive changes in potential risk for communities living near these facilities. However, the nature and location of the emission changes are uncertain. Moreover, there is insufficient information at this time about which facilities will change reclamation processes. The proximity analysis of these communities demonstrates that:

- Total baseline cancer risk and total respiratory risk from air toxics (not all of which stem from HFC reclamation) is generally higher within 1-10 miles of an HFC reclamation facility;
- Higher percentages of low income and very low-income individuals live near HFC reclamation facilities compared to the overall average at the national level;
- Generally, higher percentages of Black or African American individuals live near these facilities;
- Higher percentages of individuals whose race is identified as “Other” live near these facilities;
- Higher percentages of individuals of Hispanic ethnicity live near these facilities;

- It is not clear the extent to which these baseline risks are directly related to HFC reclamation and
- continued analysis of HFC reclamation facilities and associated environmental justice concerns is appropriate.

Given limited information at this time, it is unclear to what extent this rule will impact existing disproportionate adverse effects on communities living near HFC reclamation facilities.[40] The Agency will continue to evaluate the impacts of this proposed rulemaking on communities with environmental justice concerns and consider further action, as appropriate, to protect health in communities affected by HFC reclamation.

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Appendices:

Appendix A.Vintaging Model Leak Rate Distributions

The Vintaging Model simulates equipment emissions and consumption using average leak rates, consistent with *2006 IPCC Guidelines for National Greenhouse Gas Inventories* (IPCC 2006).[41] These average leak rates represent the full spectrum of potential equipment leak events, in which equipment may experience negligible or more significant and/or catastrophic leaks. In order to simulate a more real-world distribution of leak rates, equipment stock was distributed into quintiles, each containing 20 percent of units, where the leak rate distributions equal the weighted average leak rate modeled in the Vintaging

[41] For chillers, large retail food (rack systems), cold storage, and industrial process refrigeration systems, the leak rate distributions were applied to the average leak rate modeled in the Vintaging Model as of 2025 with a 40 percent leak rate reduction, which is consistent with the assumption that larger refrigeration and AC equipment will experience enhanced leak recovery under the 2024 Allocation Rule as explained in the RIA to the Allocation Framework Rule and associated addenda to that RIA.

Model for each equipment type. The representative leak rate for each quintile was estimated such that each subsector has at least 20 percent of its stock (i.e., one quintile) above the threshold leak rate.

Table A-0 summarizes the leak rate distributions for equipment containing 15 or more pounds of refrigerant considered in the analysis and equipment between 5 and 15 pounds of refrigerant, for the alternate policy scenario summarized in Appendix F.

For most subsectors, the quintiles were established in increments of 25% percent above or below the average leak rate (i.e., quintile 1 is 50 percent below, quintile 2 is 25 percent below, quintile 3 is the average, quintile 4 is 25 percent above, and quintile 5 is 50 percent above). However, for some subsectors, the average leak rate modeled in the Vintaging Model was significantly below the threshold leak rate, such that the upper quintile leak rate did not exceed the threshold leak rate. In those cases, the fifth quintile leak rate was set to be significantly higher than the average leak rate to ensure that each subsector had some portion of equipment stock above the leak rate threshold and therefore was affected by the proposed rulemaking. In those cases, the quintile 1 through 4 values were also manipulated such that the weighted average leak rate across all five quintiles still equaled the average leak rate (i.e., quintile 3).[42]

Table A-1: Leak Rate Distributions for Equipment

Sector	Equipment Type	Vintaging Model Subsector		Quintile 1	2	3	4	5	Average Leak Rate
Subsectors between 15 and 50 pounds									
CC	Passenger Train AC	Passenger Train AC	% Relative to Average	0.88	1.1	1.4	1.6	495	2.1
			Assumed Leak Rate (%)	0.018	0.023	0.029	0.034	10	
CC	School & Tour Bus AC	School & Tour Bus AC[a]	% Relative to Average	50	75	100	125	150	10
			Assumed Leak Rate (%)	4.8	7.2	10	12	14	
CR	Rail Transport AC	Vintage Rail Transport	% Relative to Average	25	50	100	150	175	36
			Assumed Leak Rate (%)	15	24	36	48	57	
CR	Condensing Unit	HCFC-22 Large Condensing Units (Medium Retail Food)[c]	% Relative to Average	50	75	100	125	150	15

[42] Because the average Vintaging Model leak rate for certain subsectors (e.g., chillers, IPR) are significantly lower than the threshold leak rates of 10% for comfort cooling and 30% for IPR, it is not possible for the weighted average leak rate across the quintiles to equal the average leak rate using the percentages above.

Sector	Equipment Type	Vintaging Model Subsector		Quintile 1	2	3	4	5	Average Leak Rate
			Assumed Leak Rate (%)	6.5	11	15	19	23	
CC	Transit Bus AC	Transit Bus AC	% Relative to Average	50	75	100	125	150	10
			Assumed Leak Rate (%)	5	7.5	10	12	15	
CC	Modern Rail Transport	Modern Rail Transport	% Relative to Average	50	75	100	125	150	33
			Assumed Leak Rate (%)	17	25	33	41	50	
Subsectors greater than 50 pounds									
CC	Chiller	CFC-11 Centrifugal Chillers[b]	% Relative to Average	0	0	0	0	850	2.2
			Assumed Leak Rate (%)	0	0	0	0	11	
CC	Chiller	CFC-12 Centrifugal Chillers[b]	% Relative to Average	0	0	0	0	700	2.0
			Assumed Leak Rate (%)	0	0	0	0	10	
CC	Chiller	R-500 Chillers[b]	% Relative to Average	0	0	0	0	700	2.0
			Assumed Leak Rate (%)	0	0	0	0	10	
CC	Chiller	CFC-114 Chillers[b]	% Relative to Average	0	0	0	0	750	2.1
			Assumed Leak Rate (%)	0	0	0	0	10	
CC	Chiller	Screw Chillers[b]	% Relative to Average	0	0	0	0	1300	2.1
			Assumed Leak Rate (%)	0	0	0	0	10	
CC	Chiller	Scroll Chillers[b]	% Relative to Average	0	0	0	0	1300	2.1
			Assumed Leak Rate (%)	0	0	0	0	10	
CC	Chiller	Reciprocating Chillers[b]	% Relative to Average	0	0	0	0	850	2.0
			Assumed Leak Rate (%)	0	0	0	0	10	
IPR	IPR	CFC-11 Industrial Process Refrigeration[b]	% Relative to Average	0	0	0	0	850	6.8
			Assumed Leak Rate (%)	0	0	0	0	34	
IPR	IPR	CFC-12 Industrial Process Refrigeration[b]	% Relative to Average	0	0	0	0	1250	6.0
			Assumed Leak Rate (%)	0	0	0	0	30	
IPR	IPR	HCFC-22 Industrial Process Refrigeration	% Relative to Average	0	0	0	0	500	6.2
			Assumed Leak Rate (%)	0	0	0	0	31	

Sector	Equipment Type	Vintaging Model Subsector		Quintile					Average Leak Rate
				1	2	3	4	5	
CR	Cold Storage	CFC-12 Cold Storage	% Relative to Average	0	50	75	100	275	9.2
			Assumed Leak Rate (%)	0	4.6	6.9	9.2	25	
CR	Cold Storage	HCFC-22 Cold Storage	% Relative to Average	0	50	75	100	275	7.3
			Assumed Leak Rate (%)	0	3.7	5.5	7.3	20	
CR	Cold Storage	R-502 Cold Storage	Assumed Leak Rate (%)	0	50	75	100	275	8.3
			% Relative to Average	0	4.2	6.3	8.3	23	
CR	Rack	CFC-12 Large Retail Food	Assumed Leak Rate (%)	50	75	100	125	150	15
			% Relative to Average	7.5	11	15	19	22	
CR	Rack	R-502 Large Retail Food	Assumed Leak Rate (%)	50	75	100	125	150	15
			Assumed Leak Rate (%)	7.5	11	15	19	22	
CR	Marine Transport	Merchant Fishing Transport	% Relative to Average	50	75	100	125	150	33
			Assumed Leak Rate (%)	17	25	33	41	50	
CR	Marine Transport	Reefer Ships	% Relative to Average	50	75	100	125	150	23
			Assumed Leak Rate (%)	12	17	23	29	35	

Note: Values may not sum due to independent rounding
[a] The average leak rate modeled does not equal the average leak rate for these subsectors in the Vintaging Model.
[b] 33 percent of units in the School & Tour Bus AC sector are modeled with a charge size above 15 lbs.
[c] Vintaging Model subsectors are often defined by the ODS that was original used, as that affects the transition choices. This analysis does not consider the effects the proposed rule may have on ODS emissions.

Table A-2: Leak Rate Distributions for Equipment between 5 and 15 pounds

Sector	Equipment Type	Vintaging Model Subsector		Quintile					Average Leak Rate
				1	2	3	4	5	
Subsectors between 5 and 15 pounds									
IPR	Ice Makers	Ice Makers[a]	% Relative to Average	15	30	45	60	350	3.0
			Assumed Leak Rate (%)	0.45	0.90	1.4	1.8	11	
CR	Road Transport	Road Transport	% Relative to Average	50	75	100	125	150	33
			Assumed Leak Rate (%)	17	25	33	41	50	
CR	Intermodal Containers	Intermodal Containers	% Relative to Average	50	75	100	125	150	21

Sector	Equipment Type	Vintaging Model Subsector		Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5	Average Leak Rate
			Assumed Leak Rate (%)	10	16	21	26	31	
CC	School & Tour Bus AC	School & Tour Bus AC[b]	% Relative to Average	50	75	100	125	150	10
			Assumed Leak Rate (%)	4.8	7.2	10	12	14	
CR	Condensing Units	HCFC-22 Small Condensing Units (Medium Retail Food)	% Relative to Average	0	25	75	100	300	7.8
			Assumed Leak Rate (%)	0	1.9	5.8	7.8	23	

[a] The average leak rate modeled does not equal the average leak rate for these subsectors in the Vintaging Model.
[b] 66 percent of units in the School & Tour Bus AC sector are modeled with a charge size below 15 lbs.
[c] Vintaging Model subsectors are often defined by the ODS that was original used, as that affects the transition choices. This analysis does not consider the effects the proposed rule may have on ODS emissions.

Appendix B.Evaluation of Potential Costs and Benefits of Reclamation

Demand for Reclaimed Refrigerant

The proposed requirement to use reclaimed refrigerant to fill new equipment and service existing systems in specific sectors and subsectors could result in both cost savings and avoided GHG emissions associated with avoiding virgin production and destruction of HFC refrigerant. The refrigerant consumption in the proposed (sub)sectors estimated in EPA's Vintaging Model is approximately 40,100 MT in 2028 and 40,300 MT in 2029 (EPA 2023a), as shown in **Error! Reference source not found.**. Note that these totals only reflect the AIM-listed HFCs; for example, HFOs, whether neat or in a blend with HFCs, are not included because the proposal to require reclaimed refrigerants applies only to the regulated HFCs.

Table B-1: Initial Charge and Service Demand of HFCs for Applicable Subsectors in 2028 and 2029

Sector	Equipment Type	2028		2029	
		Initial Charge (MT)	Service Demand (MT)	Initial Charge (MT)	Service Demand (MT)
Residential and Light Commercial AC	Residential Unitary AC	10,607	N/A[a]	10,519	N/A
	Small Commercial Unitary AC	1,502	N/A	1,589	N/A
	Large Commercial Unitary AC	149	N/A	183	N/A
	Window Units	5,827	N/A	5,943	N/A
	Packaged terminal AC/heat pumps (PTAC/PTHP)	248	N/A	247	N/A
	Ground-source heat pumps (GSHP)	276	N/A	270	N/A
Cold Storage Warehouses		0	N/A	0	N/A
Industrial Process Refrigeration		0	N/A	0	N/A
Stand-Alone Retail Food Refrigeration		197	20	201	20
Supermarket Systems		3,272	12,910	3,314	12,925
Refrigerated Transport	Road	401	1,512	397	1,532
	Vintage	0	13	0	11
	Modern Rail	3	10	3	10

Sector	Equipment Type	2028		2029	
		Initial Charge (MT)	Service Demand (MT)	Initial Charge (MT)	Service Demand (MT)
	Intermodal Containers	118	290	120	301
	Marine	329	1,869	335	1,964
Automatic Commercial Ice Makers		384	114	354	109
Total		**23,314**	**16,738**	**23,476**	**16,870**

[a] Not Applicable (mandatory use of reclaimed refrigerant not proposed for servicing the subsector.

These reclaimed refrigerant needs are shown by species in Table B-2 through Table B-5, below. In 2029, the required reclaimed refrigerants for initial charge and service in the subsectors specified are estimated to be 19,418 MT HFC-32, 10,543 MT HFC-125, 6,438 HFC-134a, and 3,948 MT HFC-143a. In 2028, the totals are estimated at 18,916 MT HFC-32, 10,702 MT HFC-125, 6,284 MT HFC-134a, and 4,150 MT HFC-143a.

Table B-2. Initial Charge Demand of HFCs for Applicable Subsectors in 2028

Sector	Equipment Type	Initial Charge (MT)			
		HFC-32	HFC-125	HFC-134a	HFC-143a
Residential and Light Commercial AC	Residential Unitary AC	10,607	0	0	0
	Small Commercial Unitary AC	1,232	270	0	0
	Large Commercial Unitary AC	142	2	5	0
	Window Units	4,105	1,722	0	0
	Packaged terminal AC/heat pumps (PTAC/PTHP)	189	60	0	0
	Ground-source heat pumps (GSHP)	122	54	101	0
Cold Storage Warehouses		0	0	0	0
Industrial Process Refrigeration		0	0	0	0
Stand-Alone Retail Food Refrigeration		26	27	144	0
Supermarket Systems		536	1,329	1,087	320

Sector	Equipment Type	Initial Charge (MT)			
		HFC-32	HFC-125	HFC-134a	HFC-143a
Refrigerated Transport	Road	17	199	42	142
	Vintage	0	0	0	0
	Modern Rail	0	1	2	1
	Intermodal Containers	4	24	88	2
	Marine	4	136	45	143
Automatic Commercial Ice Makers		0	127	108	150
Total		**16,985**	**3,949**	**1,621**	**759**

Table B-3: Service Demand of HFCs for Applicable Subsectors in 2028

Sector	Equipment Type	Service Demand (MT)			
		HFC-32	HFC-125	HFC-134a	HFC-143a
Stand-Alone Retail Food Refrigeration		2	2	16	0.3
Supermarket Systems		1,884	5,297	3,874	1,855
Refrigerated Transport	Road	20	626	198	668
	Vintage	0	0	13	0
	Modern Rail	0	2	5	3
	Intermodal Containers	2	14	267	7
	Marine	24	774	258	813
Automatic Commercial Ice Makers		0	38	32	44
Total		**1,931**	**6,753**	**4,663**	**3,391**

Table B-4: Initial Charge Demand of HFCs for Applicable Subsectors in 2029

Sector	Equipment Type	Initial Charge (MT)			
		HFC-32	HFC-125	HFC-134a	HFC-143a
Residential and Light Commercial AC	Residential Unitary AC	10,519	0	0	0
	Small Commercial Unitary AC	1,430	159	0	0

Sector	Equipment Type	Initial Charge (MT)			
		HFC-32	HFC-125	HFC-134a	HFC-143a
	Large Commercial Unitary AC	176	2	5	0
	Window Units	4,322	1,621	0	0
	Packaged terminal AC/heat pumps (PTAC/PTHP)	212	35	0	0
	Ground-source heat pumps (GSHP)	131	40	100	0
Cold Storage Warehouses		0	0	0	0
Industrial Process Refrigeration		0	0	0	0
Stand-Alone Retail Food Refrigeration		27	27	147	0
Supermarket Systems		543	1,346	1,101	324
Refrigerated Transport	Road	22	213	37	126
	Vintage	0	0	0	0
	Modern Rail	0	1	2	1
	Intermodal Containers	6	32	80	2
	Marine	4	139	46	146
Automatic Commercial Ice Makers		0	117	99	138
Total		**17,392**	**3,732**	**1,616**	**737**

Table B-5: Service Demand of HFCs for Applicable Subsectors in 2029

Sector	Equipment Type	Service Demand (MT)			
		HFC-32	HFC-125	HFC-134a	HFC-143a
Stand-Alone Retail Food Refrigeration		2	2	15	0.3
Supermarket Systems		1,970	5,283	4,028	1,645
Refrigerated Transport	Road	26	652	195	658
	Vintage	0	0	11	0
	Modern Rail	0	2	5	3
	Intermodal Containers	3	21	270	7
	Marine	26	815	267	857

Sector	Equipment Type	Service Demand (MT)			
		HFC-32	HFC-125	HFC-134a	HFC-143a
Automatic Commercial Ice Makers		0	36	30	42
Total		**2,026**	**6,811**	**4,822**	**3,211**

Potential Cost Savings from Reclamation

The proposed requirement to use reclaimed refrigerant would reduce the need for virgin production of refrigerant, which some research indicates could result in cost-savings and benefits. Yasaka et al. (2023) performed a life cycle assessment for the virgin production, destruction, and reclamation of R-410A, HFC-32, and HCFC-22 in Europe and Japan and found that the reclamation process had lower energy consumption and costs and emitted fewer greenhouse gas (GHG) emissions compared to production and destruction, regardless of the refrigerant type or plant location. Although similar information specific to the U.S. market were not available, below we use this study to estimate potential benefits associated with the proposed requirement to use reclaimed refrigerant.

The Yasaka et al. (2023) study evaluates HCFC-22, HFC-32, HFC-125, HFC-134a, and R-410A and chooses to summarize information on HFC-32 produced, destroyed or reclaimed in Japan. To be conservative, we use these estimates and note that of the HFC/country pairs evaluated, this was the lowest GHG emissions associated with virgin production. Overall costs associated with virgin production, destruction, and reclamation per kilogram of refrigerant evaluated in Yasaka et al. (2023) are summarized in **Error! Reference source not found.**. As shown, refrigerant reclamation could result in up to $0.58 in savings per kilogram of refrigerant compared to destruction of recovered refrigerant and virgin production to meet new demand.

Table B-6: Costs of Virgin Production, Destruction, and Reclamation ($/kg of refrigerant)[a]

Virgin Production	Destruction	Reclamation	Incremental Cost Difference (Virgin Production + Destruction – Reclamation)
$0.24	$0.38	$0.04	$0.58

Source: Yasaka et al. (2023).
[a] Estimated based on production, destruction, and reclamation of HFC-32 in Japan.

Yasaka et al. (2023) also estimated GHG emissions associated with virgin production, destruction, and reclamation, shown in **Error! Reference source not found.**. As shown, refrigerant reclamation could result in up to 9.96 kg of CO_2-equivalent avoided per kilogram of refrigerant compared to destruction of recovered refrigerant and virgin production to meet new demand.

Table B-7: GHG Emission Reductions Associated with Virgin Production, Destruction, and Reclamation (kgCO2eq/kg of produced refrigerant)[a]

Virgin Production	Destruction	Reclamation	Incremental Emission Reductions (Virgin Production + Destruction – Reclamation)
7.77	3.77	1.58	9.96

Source: Yasaka et al. (2023).
[a] Estimated based on production, destruction, and reclamation of HFC-32 in Japan.

To estimate potential costs and benefits of the proposed reclamation requirement, the incremental costs and avoided GHG emissions were multiplied by estimated new demand and servicing in 2028 and 2029 in the Vintaging Model. The values above for the years 2028 and 2029 were extrapolated out to 2050 with assumptions on growth and transition from the Vintaging Model. The amount of emissions prevented was estimated by the reduction of demand for virgin HFCs, reduced by 15% to account for the maximum virgin percentage of reclaim, then further reduced 67% to account for losses in reclaim processes and the eventual emissions of reclaimed HFCs. As shown in **Error! Reference source not found.**, the proposed reclamation requirement could result in up to $267 million in climate benefits and $265 million in net benefits 2028 to 2050, discounted to 2024.

Table B-8: Incremental Annual Cost Savings and GHG Emission Reductions Associated with Reclamation (Thousands 2022$)

Year	Benefits	Costs	Net Benefits
2028	$15,000	$110	$14,890
2029	$15,500	$110	$15,390
2030	$15,900	$110	$15,790
2031	$15,700	$111	$15,589
2032	$15,700	$110	$15,590
2033	$15,000	$111	$14,889
2034	$15,000	$110	$14,890
2035	$15,000	$110	$14,890
2036	$15,000	$110	$14,890

Year	Benefits	Costs	Net Benefits		
2037	$15,000	$109		$14,891	
2038	$15,000	$109		$14,891	
2039	$15,100	$109		$14,991	
2040	$15,000	$109		$14,891	
2041	$15,300	$109		$15,491	
2042	$15,600	$109		$15,491	
2043	$16,000	$108		$15,892	
2044	$15,900	$108		$15,792	
2045	$16,000	$108		$15,892	
2046	$16,000	$108		$15,892	
2047	$16,000	$109		$15,891	
2048	$16,100	$109		$15,991	
2049	$16,000	$110		$15,890	
2050	$16,100	$111		$15,989	
d.r.	3%	3%	7%	3%	7%
NPV	$267,000	$1,838	$1.157	$265,000	$266,000
EAV	$14,508	$100	$91	$14,408	$14,417

Appendix C.Cylinder Management

C.1. Introduction

Most HFCs, including those used as refrigerants, are gases at room temperature and are typically transported and stored as compressed liquids in pressurized metal containers called cylinders. There are two primary types of cylinders. Disposable (also known as non-refillable or single-use or DOT-39) cylinders are used once before disposal, whereas refillable cylinders can be used multiple times throughout the cylinder lifetime. Disposable cylinders today are typically discarded with refrigerants still in the cylinders, including from amounts commonly referred to as heels (i.e., the small amount of refrigerant that remains in an “empty” cylinder). These residual refrigerants are emitted over time as they leak out or are expelled when the cylinder is crushed for disposal or metal recycling. So-called “30-pound” metal cylinders are most often disposable but may come in refillable designs as well and are used primarily in the stationary air-conditioning and refrigeration system servicing industry and, to a lesser extent, in motor vehicle air conditioning.

The provisions of this proposed rule include proposed requirements to recover the refrigerant from disposable cylinders before the cylinders are discarded. The emission reductions from the proposed requirements to recover the heels from disposable cylinders used for servicing, repair, disposal, or installation of equipment are discussed below. Both disposable and refillable cylinders will be available for transporting refrigerant; however, additional costs that may be borne through the management and tracking of both disposable and refillable cylinders as proposed in this rule are included in this draft RIA Addendum.

EPA has prepared a report, Refrigerant Cylinders: Analysis of Use, Disposal, and Distribution of Refrigerants (EPA 2023), analyzing the costs and benefits of the proposed requirement that disposable cylinders that have been used for the servicing, repair, or installation of refrigerant-containing equipment be transported to an EPA-certified reclaimer, and that reclaimers remove all HFCs from disposable cylinders prior to disposal. This Appendix presents a summary of the results from this report.

C.2. Emission Estimates for Recovery of Cylinder Heels

The report assesses the typical distribution of refrigerants in cylinders, including refrigerant changes expected under the Allocation Framework Reference Case. Heels remaining in disposable cylinders were determined through both a theoretical and empirical study. Based on the wide range of disposal practices currently employed and expected to continue in absence of this proposed Rule, three scenarios were developed to estimate the emissions avoided: a most likely scenario, a low scenario (i.e., a lower heel left in the cylinder), and a high scenario. Other emissions associated with cylinders—for example, during transport and storage—are not expected to change based on this proposed Rule. Table C-1, below, presents the avoided emissions for the years 2025 through 2050.

Table C- 1: Estimated Annual Emission Changes Compared with BAU, 2025–2050

Year	Average HFC GWP	Emission Changes Relative to BAU ($MMTCO_2e$)		
		Most Likely	Low	High
2025	1,928	-3.74	-1.72	-5.63
2026	1,882	-3.65	-1.68	-5.50
2027	1,834	-3.56	-1.64	-5.36
2028	1,781	-3.46	-1.59	-5.20
2029	1,714	-3.33	-1.53	-5.01
2030	1,639	-3.18	-1.47	-4.79
2031	1,557	-3.02	-1.39	-4.55
2032	1,470	-2.85	-1.31	-4.29
2033	1,374	-2.67	-1.23	-4.01
2034	1,330	-2.58	-1.19	-3.89
2035	1,288	-2.50	-1.15	-3.76
2036	1,249	-2.43	-1.12	-3.65
2037	1,209	-2.35	-1.08	-3.53
2038	1,169	-2.27	-1.05	-3.41
2039	1,131	-2.19	-1.01	-3.30
2040	1,094	-2.12	-0.98	-3.19
2041	1,057	-2.05	-0.94	-3.09
2042	1,020	-1.98	-0.91	-2.98
2043	982	-1.91	-0.88	-2.87
2044	950	-1.84	-0.85	-2.78
2045	925	-1.80	-0.83	-2.70
2046	906	-1.76	-0.81	-2.65
2047	893	-1.73	-0.80	-2.61
2048	887	-1.72	-0.79	-2.59
2049	882	-1.71	-0.79	-2.58
2050	878	-1.71	-0.79	-2.57
Total		**-64.11**	**-29.53**	**-96.46**

C.3. Cost Estimates for Recovery of Cylinder Heels

The report also assesses the cost implications for the proposed requirement for heel recovery, accounting for the costs associated with the change in procedure handling of cylinders (i.e., returning the cylinders to be recovered) and the potential savings from avoided refrigerant loss from heel emissions, The analysis assumes that 50 percent of the cylinders will be returned to a wholesaler, who will ship disposable cylinders to a reclaimer, and the other 50 percent will be sent directly to the reclaimer. Accounting for the fuel and labor associated with the additional shipment of cylinders, the report estimates these costs and benefits, and hence the net benefits, as shown in .

Table C- 2: Costs, Benefits, and Net Benefits of Cylinder Management (Millions 2022$)

Year	**Benefits**	**Costs**		**Net Benefits**	
2025	$289	$0.4		$289	
2026	$290	$0.4		$290	
2027	$290	$0.4		$290	
2028	$289	$0.4		$289	
2029	$285	$0.4		$285	
2030	$280	$0.5		$280	
2031	$273	$0.5		$273	
2032	$264	$0.5		$263	
2033	$254	$0.5		$254	
2034	$252	$0.5		$252	
2035	$250	$0.5		$250	
2036	$249	$0.5		$248	
2037	$247	$0.5		$247	
2038	$244	$0.5		$244	
2039	$242	$0.5		$241	
2040	$240	$0.6		$240	
2041	$238	$0.6		$238	
2042	$235	$0.6		$234	
2043	$231	$0.6		$231	
2044	$229	$0.6		$229	
2045	$228	$0.6		$227	
2046	$228	$0.6		$228	
2047	$230	$0.6		$229	
2048	$234	$0.6		$233	
2049	$237	$0.7		$236	
2050	$241	$0.7		$240	
d.r.	3%	3%	7%	3%	7%
NPV	$4,463	$9.1	$5.6	$4,453	$4,457
EAV	$257	$0.5	$0.8	$257	$256

References:

U.S. Environmental Protection Agency (EPA). 2023. Refrigerant Cylinders: Analysis of Use, Disposal, and Distribution of Refrigerants.

Appendix D. Analysis of Provisions Impacting the Fire Suppression Sector

Background

As detailed in the rule preamble, the subsection (h) rule as proposed includes the following provisions specifically covering the fire suppression equipment sector:

1. minimize release of HFCs,
2. require the use of recycled HFCs for initial charge, and
3. require the use of recycled HFCs for servicing/refilling equipment.

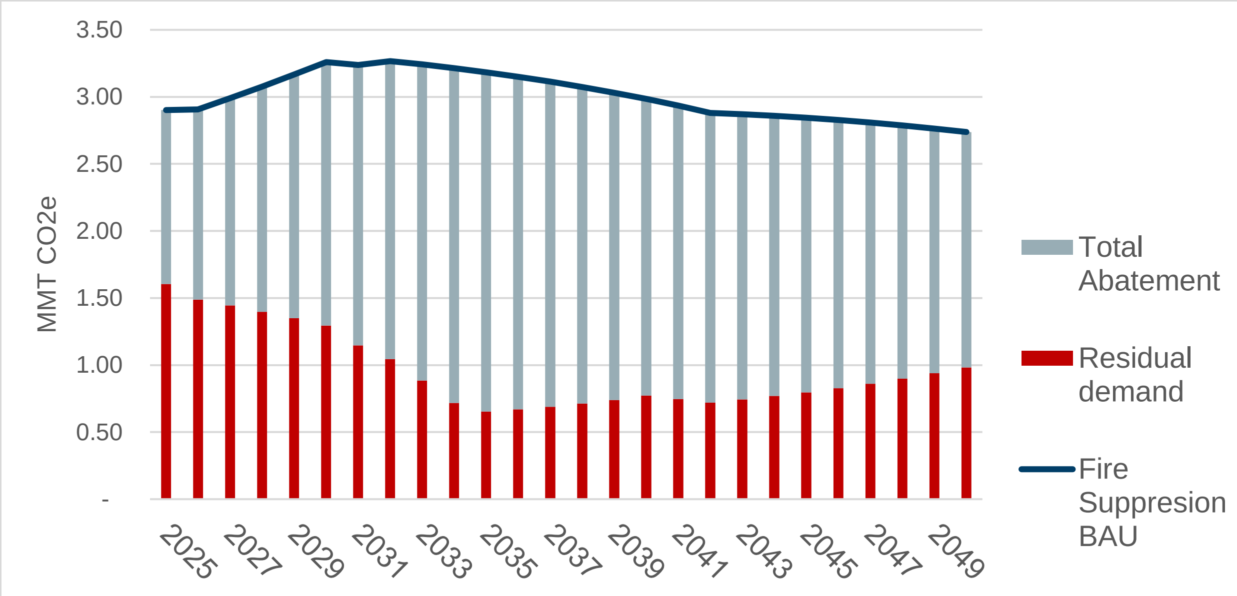
Based on estimates from EPA's Vintaging Model, annual demand for HFCs used in fire suppression equipment ranged from approximately 2.8 to 3.7 $MMTCO_2e$ from 2010 through 2020. The primary HFC gases utilized in the fire suppression sector (including in total flooding systems and streaming applications) include HFC-125 (GWP of 3,500), HFC-227ea (GWP of 3,220), and HFC-236fa (GWP of 9,810). To a lesser extent, HFC-23 (GWP of 14,800) is also used.

Potential Incremental Benefits

Avoiding the consumption and eventual release of these gases through provisions aimed at maximizing the use of recycled as opposed to virgin HFCs and minimizing emissions over the course of equipment lifetime could result in significant climate benefits. However, to avoid double counting and potential overestimation of any benefits, this analysis considers the impact of the already-in-place policy and requirements under the Allocation Framework Rule and 2024 Allocation Rule.

As described in the Allocation Framework Rule RIA and 2024 Allocation Rule RIA Addendum, EPA previously modeled the costs and benefits of the Allocation Framework Rule through the use of the Vintaging Model and a MACC methodology. The analysis demonstrated significant net benefits of the Allocation Framework Rule and anticipated transitions away from HFCs across virtually all subsectors that currently rely on these gases, including fire suppression equipment. As shown in Figure D-1 below, in the analysis EPA estimated that approximately two-thirds of the total flooding fire suppression equipment sector would transition away from HFCs to alternatives over the 2025–2050 period. The analysis did not assume any additional transition from the streaming fire suppression sector. The residual demand for HFCs for fire suppression servicing and initial charge is also shown in Figure D-1.

Figure D-1: Fire Suppression Avoided Consumption and Residual Demand under Allocation Framework Rule Compliance Path



As shown in the figure above, while most of the total flooding sector was assumed to transition in order to meet compliance with the HFC phasedown, approximately one-third of servicing and initial charge demand was not previously assumed to transition away from HFCs. For the purposes of this analysis, we assume that incremental benefits of this rule may be quantified using this residual demand for HFCs as a starting point. Since this proposed rule would require that 100 percent of both the first charge and any servicing/recharge for covered fire-suppression equipment would have to be met by recycled HFCs, a high-end estimate of the incremental benefits of this rule can be quantified as the total residual demand not previously assumed to transition, assuming that demand was met with virgin HFCs. This high-end estimate, however, would assume that the additional reduction in HFC demand in the fire suppression sector would not be offset by additional HFC consumption and production in other sectors representing a far larger share of HFC demand. In other words, it would assume that consumption and/or production allowances freed up by the fire suppression sector under the HFC Allocation trading system would not be used.

Given this inherent uncertainty, EPA estimates that incremental benefits of the provisions of this proposed rule would range from an average of 0.96 $MMTCO_2e$ annually in avoided consumption (no offsetting allowance activity), to 0 $MMTCO_2$ annually (full offsetting allowance activity).

In addition to offsetting effects under the allowance trading system, EPA notes that a significant portion of the fire suppression market already uses recycled HFCs to meet servicing and recharge demand.

According a 2022 report from the Halon Alternatives Research Corporation (HARC), approximately 80% of reported HFCs sold for the recharging of fire protection came from recyclers in 2020, and in recent years this number has averaged approximately 75%.[43] For this reason too, the above 0.96 $MMTCO_2e$ would likely be an overestimate of any incremental benefits of this rule over the baseline use of recycled HFCs.

Potential incremental costs

At this time, EPA does not have evidence to suggest significant incremental costs associated with the proposed provisions affecting the fire suppression sector. As mentioned above, a significant share of the industry (as much as 80 percent) already reports the use of recycled HFCs to meet servicing demand and the recharge of fire suppression equipment.

Costs of virgin HFCs may be rising vis-a-vis the cost of reclaimed HFCs, and already there is evidence suggesting this dynamic. As noted in the preamble for this proposed rule, a recent report by the Montreal Protocol's Technology and Economic Assessment Panel's (TEAP) Fire Suppression Technical Options Committee (FSTOC) noted that the HFC phasedown in the United States is already having a large effect on the market for HFCs used as fire extinguishants, citing that there has "already been significant impact on cost of HFCs."[44] As noted in the report, the sector may already be seeing significant effects because it relies on HFCs that are relatively high-GWP (thus requiring more consumption/production allowances given that the allocation mechanism in the US is GWP-weighted), and has a relatively small market size compared to other major sources of demand for HFCs. In addition, in a recent response to an EPA Notice of Data Availability, HARC noted that under the AIM Act allowance system, the "price of virgin HFCs for fire suppression has risen significantly to the point that recycled HFCs may now be lower in price than virgin HFCs in some cases."[45]

Given the substantial use of recycled HFCs in the industry already, as well as the likelihood of increased cost-effectiveness of recycled HFCs vis a vis virgin HFCs in the fire suppression sector, EPA does not at this time anticipate significant incremental costs to industry resulting from these proposed provisions.

[43] Halon Alternatives Research Corporation (HARC). "Report of the HFC Emissions Estimating Program (HEEP) 2002-2020 Data Collection. October 2022. Available online at: https://www.harc.org/_files/ugd/4e7dd1_64188eee6f554bf5966fbd24f97b552a.pdf

[44] UNEP, "TEAP 2022 Assessment: Report of the Fire Suppression Technical Options Committee," December 2022, available at: https://ozone.unep.org/system/files/documents/FSTOC-2022-Assessment.pdf.

[45] HARC. Comments submitted Re: Notice of Data Availability Relevant to Management of Regulated Substances Under the American Innovation and Manufacturing Act of 2020; Docket ID No EPA–HQ–OAR–2022–0606, 87 Fed. Reg. 62843. November 7, 2022.

Appendix E. Detailed Costs by Equipment – Leak Repair and Inspection

Table E-1: Total Annual Refrigerant Savings in 2030 (2022$) and Combined Annual Cost and Annual Savings with 7% and 3% Discount Rate by Equipment Type

Sector	Equipment Type		Annual Refrigerant Savings	7% Discount Rate		3% Discount Rate	
				Incremental Compliance Costs	Combined Annual Savings and Compliance Costs	Incremental Compliance Costs	Combined Annual Savings and Compliance Costs
			2030	2030	2030	2030	2030
Leak Repair			**-$13,916,300**	**$22,070,700**	**$8,154,400**	**$10,525,200**	**-$3,391,200**
CC	School & Tour Bus AC	Sub-Small	-$20,700	$2,377,900	$2,357,200	$1,129,500	$1,108,700
	Transit Bus AC	Sub-Small	-$12,400	$842,400	$829,900	$400,100	$387,700
	Train AC	Sub-Small	-$6,500	$131,500	$124,900	$62,500	$55,900
	Chiller	Medium	-$3,832,800	$10,614,700	$6,781,900	$5,078,900	$1,246,100
	Chiller	Large	-$133,500	$153,600	$20,100	$73,100	-$60,400
CR	Modern Rail Transport	Sub-Small	-$4,900	$106,900	$102,000	$50,800	$45,900
	Condensing Unit	Sub-Small	-$195,400	$3,839,400	$3,643,900	$1,824,000	$1,628,600
	Vintage Rail Transport	Sub-Small	-$5,100	$39,900	$34,800	$19,000	$13,800
	Rack	Medium	-$1,078,000	$788,100	-$289,900	$375,700	-$702,300
	Rack	Large	-$1,243,800	$531,000	-$712,900	$250,000	-$993,900
	Marine Transport	Small	-$236,600	$314,300	$77,800	$149,500	-$87,100
	Marine Transport	Medium	-$1,224,700	$1,503,100	$278,400	$718,800	-$505,900
	Marine Transport	Large	-$48,200	$15,500	-$32,800	$7,300	-$41,000
	Cold Storage	Large	-$139,200	$40,900	-$98,300	$19,400	-$119,800
IPR	IPR	Medium	-$158,300	$113,200	-$45,100	$54,200	-$104,100
	IPR	Large	-$5,576,000	$658,500	-$4,917,500	$312,600	-$5,263,400
Leak Inspection			**$0**	**$70,285,000**	**$70,285,000**	**$70,285,000**	**$70,285,000**
CC	School & Tour Bus AC	Sub-Small	$0	$7,797,800	$7,797,800	$7,797,800	$7,797,800
	Transit Bus AC	Sub-Small	$0	$2,762,600	$2,762,600	$2,762,600	$2,762,600
	Train AC	Sub-Small	$0	$428,300	$428,300	$428,300	$428,300
	Chiller	Medium	$0	$13,782,800	$13,782,800	$13,782,800	$13,782,800
	Chiller	Large	$0	$155,800	$155,800	$155,800	$155,800

Sector	Equipment Type		Annual Refrigerant Savings	7% Discount Rate		3% Discount Rate	
				Incremental Compliance Costs	Combined Annual Savings and Compliance Costs	Incremental Compliance Costs	Combined Annual Savings and Compliance Costs
			2030	2030	2030	2030	2030
CR	Modern Rail Transport	Sub-Small	$0	$701,200	$701,200	$701,200	$701,200
	Condensing Unit	Sub-Small	$0	$24,979,600	$24,979,600	$24,979,600	$24,979,600
	Vintage Rail Transport	Sub-Small	$0	$260,700	$260,700	$260,700	$260,700
	Rack	Medium	$0	$4,506,300	$4,506,300	$4,506,300	$4,506,300
	Rack	Large	$0	$901,300	$901,300	$901,300	$901,300
	Marine Transport	Small	$0	$1,969,500	$1,969,500	$1,969,500	$1,969,500
	Marine Transport	Medium	$0	$9,983,100	$9,983,100	$9,983,100	$9,983,100
	Marine Transport	Large	$0	$27,100	$27,100	$27,100	$27,100
	Cold Storage	Large	$0	$26,600	$26,600	$26,600	$26,600
IPR	IPR	Medium	$0	$1,135,600	$1,135,600	$1,135,600	$1,135,600
	IPR	Large	$0	$866,700	$866,700	$866,700	$866,700
Automatic Leak Detection			**$0**	**$109,787,000**	**$109,787,000**	**$109,787,000**	**$109,787,000**
CC	School & Tour Bus AC	Sub-Small	$0	$0	$0	$0	$0
	Transit Bus AC	Sub-Small	$0	$0	$0	$0	$0
	Train AC	Sub-Small	$0	$0	$0	$0	$0
	Chiller	Medium	$0	$0	$0	$0	$0
	Chiller	Large	$0	$0	$0	$0	$0
CR	Modern Rail Transport	Sub-Small	$0	$0	$0	$0	$0
	Condensing Unit	Sub-Small	$0	$0	$0	$0	$0
	Vintage Rail Transport	Sub-Small	$0	$0	$0	$0	$0
	Rack	Medium	$0	$43,970,000	$43,970,500	$43,970,000	$43,970,500
	Rack	Large	$0	$45,460,000	$45,460,300	$45,460,000	$45,460,300
	Marine Transport	Small	$0	$0	$0	$0	$0
	Marine Transport	Medium	$0	$400,000	$400,300	$400,000	$400,300
	Marine Transport	Large	$0	$414,000	$414,400	$414,000	$414,400
	Cold Storage	Large	$0	$582,000	$581,900	$582,000	$581,900
IPR	IPR	Medium	$0	$0	$0	$0	$0
	IPR	Large	$0	$18,960,000	$18,960,000	$18,960,000	$18,960,000
Reporting & Recordkeeping			**$0**	**$13,341,300**	**$13,341,300**	**$13,341,300**	**$13,341,300**
CC, CR,	CC and CR 15–50 lb.[a]	15-50	$0	$6,827,500	$6,827,500	$9,763,400	$9,763,400

Sector	Equipment Type		Annual Refrigerant Savings	7% Discount Rate		3% Discount Rate	
				Incremental Compliance Costs	Combined Annual Savings and Compliance Costs	Incremental Compliance Costs	Combined Annual Savings and Compliance Costs
			2030	2030	2030	2030	2030
and IPR	CC, CR, and IPR ≥50 lb.	50+	$0	$6,513,900	$6,513,900	$3,987,900	$3,987,900
Total			**-$13,916,300**	**$215,480,000**	**$199,211,000**	**$203,940,000**	**$188,914,000**

Totals may not sum due to independent rounding.

Table E-2: Total Annual Refrigerant Savings in 2040 (2022$) and Combined Annual Cost and Annual Savings with 7% and 3% Discount Rate by Equipment Type

Sector	Equipment Type		Annual Refrigerant Savings	7% Discount Rate		3% Discount Rate	
				Incremental Compliance Costs	Combined Annual Savings and Compliance Costs	Incremental Compliance Costs	Combined Annual Savings and Compliance Costs
			2040	2040	2040	2040	2040
Leak Repair			**-$12,218,500**	**$23,869,900**	**$11,651,400**	**$11,384,800**	**-$833,700**
CC	School & Tour Bus AC	Sub-Small	-$23,600	$2,705,800	$2,682,200	$1,285,200	$1,261,600
	Transit Bus AC	Sub-Small	-$14,100	$958,500	$944,400	$455,300	$441,100
	Train AC	Sub-Small	-$7,200	$144,100	$136,900	$68,400	$61,300
	Chiller	Medium	-$4,322,700	$11,641,500	$7,318,800	$5,570,500	$1,247,800
	Chiller	Large	-$156,600	$179,800	$23,200	$85,600	-$71,100
CR	Modern Rail Transport	Sub-Small	-$5,200	$114,400	$109,200	$54,300	$49,100
	Condensing Unit	Sub-Small	-$200,100	$3,930,900	$3,730,800	$1,867,500	$1,667,400
	Vintage Rail Transport	Sub-Small	$0	$0	$0	$0	$0
	Rack	Medium	-$1,203,800	$880,100	-$323,800	$419,500	-$784,300
	Rack	Large	-$1,389,000	$592,900	-$796,100	$279,100	-$1,109,900
	Marine Transport	Small	-$301,100	$400,000	$99,000	$190,300	-$110,800
	Marine Transport	Medium	-$1,558,000	$1,912,600	$354,600	$914,600	-$643,400
	Marine Transport	Large	-$60,700	$19,500	-$41,300	$9,200	-$51,600
	Cold Storage	Large	-$53,600	$17,000	-$36,600	$8,100	-$45,500
IPR	IPR	Medium	-$70,800	$50,600	-$20,200	$24,200	-$46,500
	IPR	Large	-$2,852,000	$322,300	-$2,529,700	$153,100	-$2,698,900
Leak Inspection			**$0**	**$76,292,600**	**$76,292,600**	**$76,292,600**	**$76,292,600**

Sector	Equipment Type		Annual Refrigerant Savings	7% Discount Rate		3% Discount Rate	
				Incremental Compliance Costs	Combined Annual Savings and Compliance Costs	Incremental Compliance Costs	Combined Annual Savings and Compliance Costs
			2040	2040	2040	2040	2040
CC	School & Tour Bus AC	Sub-Small	$0	$8,872,800	$8,872,800	$8,872,800	$8,872,800
	Transit Bus AC	Sub-Small	$0	$3,143,500	$3,143,500	$3,143,500	$3,143,500
	Train AC	Sub-Small	$0	$469,400	$469,400	$469,400	$469,400
	Chiller	Medium	$0	$15,085,300	$15,085,300	$15,085,300	$15,085,300
	Chiller	Large	$0	$182,300	$182,300	$182,300	$182,300
CR	Modern Rail Transport	Sub-Small	$0	$750,400	$750,400	$750,400	$750,400
	Condensing Unit	Sub-Small	$0	$25,575,000	$25,575,000	$25,575,000	$25,575,000
	Vintage Rail Transport	Sub-Small	$0	$0	$0	$0	$0
	Rack	Medium	$0	$5,032,300	$5,032,300	$5,032,300	$5,032,300
	Rack	Large	$0	$1,006,500	$1,006,500	$1,006,500	$1,006,500
	Marine Transport	Small	$0	$2,506,400	$2,506,400	$2,506,400	$2,506,400
	Marine Transport	Medium	$0	$12,702,900	$12,702,900	$12,702,900	$12,702,900
	Marine Transport	Large	$0	$34,200	$34,200	$34,200	$34,200
	Cold Storage	Large	$0	$11,200	$11,200	$11,200	$11,200
IPR	IPR	Medium	$0	$507,700	$507,700	$507,700	$507,700
	IPR	Large	$0	$412,700	$412,700	$412,700	$412,700
Automatic Leak Detection			**$0**	**$108,810,000**	**$108,810,000**	**$108,810,000**	**$108,810,000**
CC	School & Tour Bus	Sub-Small	$0	$0	$0	$0	$0
	Transit Bus AC	Sub-Small	$0	$0	$0	$0	$0
	Train AC	Sub-Small	$0	$0	$0	$0	$0
	Chiller	Medium	$0	$0	$0	$0	$0
	Chiller	Large	$0	$0	$0	$0	$0
CR	Modern Rail Transport	Sub-Small	$0	$0	$0	$0	$0
	Condensing Unit	Sub-Small	$0	$0	$0	$0	$0
	Vintage Rail Transport	Sub-Small	$0	$0	$0	$0	$0
	Rack	Medium	$0	$48,465,000	$48,465,100	$48,465,000	$48,465,100
	Rack	Large	$0	$50,120,000	$50,120,200	$50,120,000	$50,120,200
	Marine Transport	Small	$0	$0	$0	$0	$0
	Marine Transport	Medium	$0	$467,000	$467,500	$467,000	$467,500
	Marine Transport	Large	$0	$484,000	$484,400	$484,000	$484,400
	Cold Storage	Large	$0	$245,000	$245,200	$245,000	$245,200

Sector	Equipment Type		Annual Refrigerant Savings	7% Discount Rate		3% Discount Rate	
				Incremental Compliance Costs	Combined Annual Savings and Compliance Costs	Incremental Compliance Costs	Combined Annual Savings and Compliance Costs
			2040	2040	2040	2040	2040
IPR	IPR	Medium	$0	$0	$0	$0	$0
	IPR	Large	$0	$9,028,000	$9,027,900	$9,028,000	$9,027,900
Reporting & Recordkeeping			**$0**	**$14,509,300**	**$14,509,300**	**$14,509,300**	**$14,509,300**
CC, CR, and IPR	CC and CR 15–50 lb.[a]	15-50	$0	$7,308,800	$7,308,800	$10,626,700	$10,626,700
	CC, CR, and IPR ≥50 lb.	50+	$0	$7,200,600	$7,200,600	$4,408,400	$4,408,400
Total			**-$12,218,500**	**$223,480,000**	**$208,581,000**	**$211,000,000**	**$197,517,000**

Totals may not sum due to independent rounding.

Table E-3: Total Annual Refrigerant Savings in 2050 (2022$) and Combined Annual Cost and Annual Savings with 7% and 3% Discount Rate by Equipment Type

Sector	Equipment Type		Annual Refrigerant Savings	7% Discount Rate		3% Discount Rate	
				Incremental Compliance Costs	Combined Annual Savings and Compliance Costs	Incremental Compliance Costs	Combined Annual Savings and Compliance Costs
			2050	2050	2050	2050	2050
Leak Repair			**-$10,165,400**	**$25,661,100**	**$15,495,800**	**$12,239,700**	**$2,074,400**
CC	School & Tour Bus AC	Sub-Small	-$25,600	$2,931,300	$2,905,700	$1,392,300	$1,366,700
	Transit Bus AC	Sub-Small	-$15,300	$1,038,400	$1,023,100	$493,200	$477,900
	Train AC	Sub-Small	-$7,800	$156,000	$148,300	$74,100	$66,400
	Chiller	Medium	-$4,725,400	$12,638,000	$7,912,700	$6,047,400	$1,322,000
	Chiller	Large	-$175,000	$200,800	$25,800	$95,600	-$79,500
CR	Modern Rail Transport	Sub-Small	-$5,700	$123,900	$118,300	$58,900	$53,200
	Condensing Unit	Sub-Small	-$220,700	$4,336,700	$4,116,000	$2,060,300	$1,839,600
	Vintage Rail Transport	Sub-Small	$0	$0	$0	$0	$0
	Rack	Medium	-$1,313,100	$960,000	-$353,200	$457,600	-$855,500
	Rack	Large	-$1,515,200	$646,800	-$868,400	$304,500	-$1,210,700
	Marine Transport	Small	-$339,700	$451,300	$111,600	$214,600	-$125,000
	Marine Transport	Medium	-$1,755,700	$2,156,600	$400,900	$1,031,300	-$724,400
	Marine Transport	Large	-$66,200	$21,200	-$45,000	$10,000	-$56,300

Sector	Equipment Type		Annual Refrigerant Savings	7% Discount Rate: Incremental Compliance Costs	7% Discount Rate: Combined Annual Savings and Compliance Costs	3% Discount Rate: Incremental Compliance Costs	3% Discount Rate: Combined Annual Savings and Compliance Costs
			2050	2050	2050	2050	2050
	Cold Storage	Large	$0	$0	$0	$0	$0
IPR	IPR	Medium	$0	$0	$0	$0	$0
	IPR	Large	$0	$0	$0	$0	$0
Leak Inspection			**$0**	**$82,902,800**	**$82,902,800**	**$82,902,800**	**$82,902,800**
CC	School & Tour Bus AC	Sub-Small	$0	$9,612,300	$9,612,300	$9,612,300	$9,612,300
	Transit Bus AC	Sub-Small	$0	$3,405,500	$3,405,500	$3,405,500	$3,405,500
	Train AC	Sub-Small	$0	$508,300	$508,300	$508,300	$508,300
	Chiller	Medium	$0	$16,368,200	$16,368,200	$16,368,200	$16,368,200
	Chiller	Large	$0	$203,600	$203,600	$203,600	$203,600
CR	Modern Rail Transport	Sub-Small	$0	$812,700	$812,700	$812,700	$812,700
	Condensing Unit	Sub-Small	$0	$28,215,500	$28,215,500	$28,215,500	$28,215,500
	Vintage Rail Transport	Sub-Small	$0	$0	$0	$0	$0
	Rack	Medium	$0	$5,489,300	$5,489,300	$5,489,300	$5,489,300
	Rack	Large	$0	$1,097,900	$1,097,900	$1,097,900	$1,097,900
	Marine Transport	Small	$0	$2,827,700	$2,827,700	$2,827,700	$2,827,700
	Marine Transport	Medium	$0	$14,324,500	$14,324,500	$14,324,500	$14,324,500
	Marine Transport	Large	$0	$37,300	$37,300	$37,300	$37,300
	Cold Storage	Large	$0	$0	$0	$0	$0
IPR	IPR	Medium	$0	$0	$0	$0	$0
	IPR	Large	$0	$0	$0	$0	$0
Automatic Leak Detection			**$0**	**$108,135,000**	**$108,135,000**	**$108,135,000**	**$108,135,000**
CC	School & Tour AC	Sub-Small	$0	$0	$0	$0	$0
	Transit Bus AC	Sub-Small	$0	$0	$0	$0	$0
	Train AC	Sub-Small	$0	$0	$0	$0	$0
	Chiller	Medium	$0	$0	$0	$0	$0
	Chiller	Large	$0	$0	$0	$0	$0
CR	Modern Rail Transport	Sub-Small	$0	$0	$0	$0	$0
	Condensing Unit	Sub-Small	$0	$0	$0	$0	$0
	Vintage Rail Transport	Sub-Small	$0	$0	$0	$0	$0
	Rack	Medium	$0	$52,650,000	$52,650,000	$52,650,000	$52,650,000
	Rack	Large	$0	$54,451,000	$54,450,600	$54,451,000	$54,450,600
	Marine Transport	Small	$0	$0	$0	$0	$0

Sector	Equipment Type		Annual Refrigerant Savings	7% Discount Rate		3% Discount Rate	
				Incremental Compliance Costs	Combined Annual Savings and Compliance Costs	Incremental Compliance Costs	Combined Annual Savings and Compliance Costs
			2050	2050	2050	2050	2050
	Marine Transport	Medium	$0	$508,000	$508,100	$508,000	$508,100
	Marine Transport	Large	$0	$526,000	$526,500	$526,000	$526,500
	Cold Storage	Large	$0	$0	$0	$0	$0
IPR	IPR	Medium	$0	$0	$0	$0	$0
	IPR	Large	$0	$0	$0	$0	$0
Reporting & Recordkeeping			**$0**	**$15,761,200**	**$15,761,200**	**$15,761,200**	**$15,761,200**
CC, CR, and IPR	CC and CR 15-50 lbs.[a]	15-50	$0	$7,990,300	$7,990,300	$7,990,300	$7,990,300
	CC, CR, and IPR ≥50 lbs.	50+	$0	$7,770,800	$7,770,800	$7,770,800	$7,770,800
Total			**-$10,165,400**	**$232,460,000**	**$219,389,000**	**$219,040,000**	**$207,507,000**

Totals may not sum due to independent rounding.

Appendix F.Evaluation of Alternative Charge Size Thresholds

To provide a full range of costs, savings, and benefits estimates, **Error! Reference source not found.** and **Error! Reference source not found.** show the compliance costs, savings, and benefits in 2025 and 2035 and **Error! Reference source not found.** shows the emission reduction benefits in 2030, 2040, and 2050 associated with an alternative policy scenario considering a 5-pound threshold for annual leak repair and inspection of CC, CR, and IPR, rather than 15 pounds. This threshold was analyzed because of the significant number of appliances exceeding the leak rate threshold within this equipment size category. Affected equipment between 5 and 15 pounds was estimated based on the leak rate distribution approach discussed in Appendix A and assumes that HFC appliances begin transitioning away from HFCs in accordance with the transition scenario presented in the RIA for the AIM Act 2024 HFC Allocation Rule.

Table F-1: 2025 Total Annual Refrigerant Savings (2022$) and Combined Annual Cost and Annual Savings with 7% and 3% Discount Rate and Benefits for Equipment 5-50 pounds

Rule Component	Annual Refrigerant Savings	Incremental Compliance Costs	Combined Annual Savings and Compliance Costs	Incremental Compliance Costs	Combined Annual Savings and Compliance Costs	GHG Emissions Avoided ($MTCO_2eq$)
		7% Discount Rate		3% Discount Rate		
Leak Repair	**-$1,384,000**	**$70,240,000**	**$68,856,000**	**$33,362,000**	**$31,978,000**	**479,000**
School & Tour Bus AC (15-30 lbs.)	-$38,000	$4,334,000	$4,296,000	$2,059,000	$2,021,000	6,000
School & Tour Bus AC (10-15 lbs.)	-$50,000	$8,656,000	$8,606,000	$4,111,000	$4,061,000	8,000
Transit Bus AC (15-30 lbs.)	-$11,000	$768,000	$757,000	$365,000	$354,000	2,000
Passenger Train AC (30-50 lbs.)	-$6,000	$119,000	$113,000	$56,000	$50,000	1,000
Road Transport (5-10 lbs.)	-$790,000	$25,797,000	$25,007,000	$12,252,000	$11,462,000	323,000
Intermodal Containers (5-10 lbs.)	-$85,000	$5,549,000	$5,464,000	$2,636,000	$2,551,000	15,000
Condensing Units (5-10 lbs.)	-$138,000	$10,620,000	$10,482,000	$5,044,000	$4,906,000	35,000
Modern Rail Transport AC (15-30 lbs.)	-$5,000	$104,000	$99,000	$50,000	$45,000	1,000
Condensing Units (30-50 lbs.)	-$180,000	$3,538,000	$3,358,000	$1,681,000	$1,501,000	61,000
Vintage Rail Transport (30-50 lbs.)	-$14,000	$105,000	$91,000	$50,000	$36,000	2,000
Ice Makers (5-10 lbs.)	-$67,000	$10,650,000	$10,583,000	$5,058,000	$4,991,000	25,000
Leak Repair Total (5-10 lbs.)	**-$1,080,000**	**$52,616,000**	**$51,536,000**	**$24,990,000**	**$23,910,000**	**$398,000**
Leak Repair Total (10-15 lbs.)	**-$50,000**	**$8,656,000**	**$8,606,000**	**$4,111,000**	**$4,061,000**	**$8,000**
Leak Repair Total (15-30 lbs.)	**-$54,000**	**$5,206,000**	**$5,152,000**	**$2,474,000**	**$2,420,000**	**$9,000**
Leak Repair Total (30-50 lbs.)	**-$200,000**	**$3,762,000**	**$3,562,000**	**$1,787,000**	**$1,587,000**	**$64,000**

Rule Component	**Annual Refrigerant Savings**	**Incremental Compliance Costs**	**Combined Annual Savings and Compliance Costs**	**Incremental Compliance Costs**	**Combined Annual Savings and Compliance Costs**	**GHG Emissions Avoided (MTCO$_2$eq)**
		7% Discount Rate		**3% Discount Rate**		
Leak Inspection		**$394,438,000**	**$394,438,000**	**$394,438,000**	**$394,438,000**	
School & Tour Bus AC (15-30 lbs.)		$7,107,000	$7,107,000	$7,107,000	$7,107,000	
School & Tour Bus AC (10-15 lbs.)		$14,213,000	$14,213,000	$14,213,000	$14,213,000	
Transit Bus AC (15-30 lbs.)		$2,518,000	$2,518,000	$2,518,000	$2,518,000	
Passenger Train AC (30-50 lbs.)		$387,000	$387,000	$387,000	$387,000	
Road Transport (5-10 lbs.)		$169,475,000	$169,475,000	$169,475,000	$169,475,000	
Intermodal Containers (5-10 lbs.)		$36,455,000	$36,455,000	$36,455,000	$36,455,000	
Condensing Units (5-10 lbs.)		$69,845,000	$69,845,000	$69,845,000	$69,845,000	
Modern Rail Transport AC (15-30 lbs.)		$684,000	$684,000	$684,000	$684,000	
Condensing Units (30-50 lbs.)		$23,022,000	$23,022,000	$23,022,000	$23,022,000	
Vintage Rail Transport (30-50 lbs.)		$686,000	$686,000	$686,000	$686,000	
Ice Makers (5-10 lbs.)		$70,046,000	$70,046,000	$70,046,000	$70,046,000	
Leak Inspection Total (5-10 lbs.)		**$345,821,000**	**$345,821,000**	**$345,821,000**	**$345,821,000**	
Leak Inspection Total (10-15 lbs.)		**$14,213,000**	**$14,213,000**	**$14,213,000**	**$14,213,000**	
Leak Inspection Total (15-30 lbs.)		**$10,309,000**	**$10,309,000**	**$10,309,000**	**$10,309,000**	
Leak Inspection Total (30-50 lbs.)		**$24,095,000**	**$24,095,000**	**$24,095,000**	**$24,095,000**	
Reporting & Recordkeeping		**$55,899,000**	**$55,899,000**	**$55,899,000**	**$55,899,000**	
Reporting & Recordkeeping (5-15 lbs.)		$49,571,000	49,571,000	$49,571,000	49,571,000	
Reporting & Recordkeeping (15-50 lbs.)		$6,328,000	6,328,000	$6,328,000	6,328,000	
Total	**-$1,384,000**	**$520,577,000**	**$519,193,000**	**$483,699,000**	**$482,315,000**	**479,000**

Note: Values may not sum due to independent rounding

Table F-2: 2025 Monetized Climate Benefits and Net Benefits with 7% and 3% Discount Rate for Equipment 5-50 pounds

Rule Component	**GHG Emissions Avoided ($MTCO_2eq$)**	**Climate Benefits (3% discount rate)**	**Combined Annual Savings and Compliance Costs**	**Net Benefits**	**Combined Annual Savings and Compliance Costs**	**Net Benefits**
			7% Discount Rate	**7% Discount Rate**	**3% Discount Rate**	**3% Discount Rate**
Leak Repair Total (5-10 lbs.)	**415,000**	**$27,896,000**	**$60,526,000**	**-$32,630,000**	**$28,137,000**	**-$241,000**
Leak Repair Total (10-15 lbs.)	**71,000**	**$5,113,000**	**$54,511,000**	**-$49,398,000**	**$25,725,000**	**-$20,612,000**
Leak Repair Total (15-30 lbs.)	**8,000**	**$786,000**	**$2,231,000**	**-$1,445,000**	**$1,041,000**	**-$255,000**
Leak Repair Total (30-50 lbs.)	**64,000**	**$6,798,000**	**$3,562,000**	**$3,236,000**	**$1,587,000**	**$5,211,000**
Leak Repair Total (5-50 lbs.)	**558,000**	**$40,593,000**	**$120,830,000**	**-$80,237,000**	**$56,490,000**	**-$15,897,000**

Note: Values may not sum due to independent rounding

Table F-3: 2035 Total Annual Refrigerant Savings (2022$) and Combined Annual Cost and Annual Savings with 7% and 3% Discount Rate and Benefits for Equipment 5-50 pounds

Rule Component	**Annual Refrigerant Savings**	**Incremental Compliance Costs**	**Combined Annual Savings and Compliance Costs**	**Incremental Compliance Costs**	**Combined Annual Savings and Compliance Costs**	**GHG Emissions Avoided ($MTCO_2eq$)**
		7% Discount Rate		**3% Discount Rate**		
Leak Repair	**-$1,629,000**	**$79,570,000**	**$77,941,000**	**$37,791,000**	**$36,162,000**	**483,000**
School & Tour Bus AC (15-30 lbs.)	-$45,000	$5,136,000	$5,091,000	$2,439,000	$2,394,000	7,000
School & Tour Bus AC (10-15 lbs.)	-$60,000	$10,257,000	$10,197,000	$4,872,000	$4,812,000	10,000
Transit Bus AC (15-30 lbs.)	-$13,000	$910,000	$897,000	$432,000	$419,000	2,000
Passenger Train AC (30-50 lbs.)	-$7,000	$138,000	$131,000	$66,000	$59,000	1,000
Road Transport (5-10 lbs.)	-$983,000	$32,096,000	$31,113,000	$15,244,000	$14,261,000	346,000
Intermodal Containers (5-10 lbs.)	-$129,000	$8,400,000	$8,271,000	$3,989,000	$3,860,000	25,000
Condensing Units (5-10 lbs.)	-$152,000	$11,718,000	$11,566,000	$5,565,000	$5,413,000	30,000
Modern Rail Transport AC (15-30 lbs.)	-$5,000	$110,000	$105,000	$52,000	$47,000	2,000
Condensing Units (30-50 lbs.)	-$191,000	$3,749,000	$3,558,000	$1,781,000	$1,590,000	44,000
Vintage Rail Transport (30-50 lbs.)	$0	$0	$0	$0	$0	-
Ice Makers (5-10 lbs.)	-$44,000	$7,056,000	$7,012,000	$3,351,000	$3,307,000	16,000

Rule Component	Annual Refrigerant Savings	Incremental Compliance Costs	Combined Annual Savings and Compliance Costs	Incremental Compliance Costs	Combined Annual Savings and Compliance Costs	GHG Emissions Avoided ($MTCO_2eq$)
		7% Discount Rate		3% Discount Rate		
Leak Repair Total (5-10 lbs.)	**-$1,308,000**	**$59,270,000**	**$57,962,000**	**$28,149,000**	**$26,841,000**	**$417,000**
Leak Repair Total (10-15 lbs.)	**-$60,000**	**$10,257,000**	**$10,197,000**	**$4,872,000**	**$4,812,000**	**$10,000**
Leak Repair Total (15-30 lbs.)	**-$63,000**	**$6,156,000**	**$6,093,000**	**$2,923,000**	**$2,860,000**	**$11,000**
Leak Repair Total (30-50 lbs.)	**-$198,000**	**$3,887,000**	**$3,689,000**	**$1,847,000**	**$1,649,000**	**$45,000**
Leak Inspection		**$443,321,000**	**$443,321,000**	**$443,321,000**	**$443,321,000**	
School & Tour Bus AC (15-30 lbs.)		$8,421,000	$8,421,000	$8,421,000	$8,421,000	
School & Tour Bus AC (10-15 lbs.)		$16,842,000	$16,842,000	$16,842,000	$16,842,000	
Transit Bus AC (15-30 lbs.)		$2,983,000	$2,983,000	$2,983,000	$2,983,000	
Passenger Train AC (30-50 lbs.)		$451,000	$451,000	$451,000	$451,000	
Road Transport (5-10 lbs.)		$210,853,000	$210,853,000	$210,853,000	$210,853,000	
Intermodal Containers (5-10 lbs.)		$55,181,000	$55,181,000	$55,181,000	$55,181,000	
Condensing Units (5-10 lbs.)		$77,069,000	$77,069,000	$77,069,000	$77,069,000	
Modern Rail Transport AC (15-30 lbs.)		$723,000	$723,000	$723,000	$723,000	
Condensing Units (30-50 lbs.)		$24,390,000	$24,390,000	$24,390,000	$24,390,000	
Vintage Rail Transport (30-50 lbs.)		$0	$0	$0	$0	
Ice Makers (5-10 lbs.)		$46,408,000	$46,408,000	$46,408,000	$46,408,000	
Leak Inspection Total (5-10 lbs.)		**$389,511,000**	**$389,511,000**	**$389,511,000**	**$389,511,000**	
Leak Inspection Total (10-15 lbs.)		**$16,842,000**	**$16,842,000**	**$16,842,000**	**$16,842,000**	
Leak Inspection Total (15–30 lb.)		**$12,127,000**	**$12,127,000**	**$12,127,000**	**$12,127,000**	
Leak Inspection Total (30–50 lb.)		**$24,841,000**	**$24,841,000**	**$24,841,000**	**$24,841,000**	
Reporting & Recordkeeping		**$63,586,000**	**$63,586,000**	**$63,586,000**	**$63,586,000**	
Reporting & Recordkeeping (5–15 lbs.)		$56,630,000	56,630,000	$56,630,000	56,630,000	
Reporting & Recordkeeping (15–50 lbs.)		$6,956,000	6,956,000	$6,956,000	6,956,000	
Total	**-$1,629,000**	**$586,477,000**	**$584,848,000**	**$544,698,000**	**$543,069,000**	**483,000**

Note: Values may not sum due to independent rounding

Table F-4: Annual GHG Emissions Avoided in 2030, 2040, and 2050 for Equipment 5–50 pounds

Rule Component	**GHG Emissions Avoided ($MTCO_2eq$)**		
	2030	**2040**	**2050**
Leak Repair and Inspection	**495,500**	**487,000**	**529,000**
School & Tour Bus AC (15-30 lbs.)	7,000	8,000	8,000
School & Tour Bus AC (10-15 lbs.)	9,000	10,000	11,000
Transit Bus AC (15–30 lbs.)	2,000	2,000	2,000
Passenger Train AC (30–50 lbs.)	1,000	1,000	1,000
Road Transport (5–10 lbs.)	343,000	344,000	371,000
Intermodal Containers (5–10 lbs.)	19,000	29,000	33,000
Condensing Units (5–10 lbs.)	34,000	31,000	34,000
Modern Rail Transport AC (15–30 lbs.)	1,500	2,000	2,000
Condensing Units (30–50 lbs.)	57,000	44,000	49,000
Vintage Rail Transport (30–50 lbs.)	1,000	-	-
Ice Makers (5–10 lbs.)	21,000	16,000	18,000
Total (5–10 lbs.)	**417,000**	**420,000**	**456,000**
Total (10–15 lbs.)	**9,000**	**10,000**	**11,000**
Total (15–30 lbs.)	**10,500**	**12,000**	**12,000**
Total (30–50 lbs.)	**59,000**	**45,000**	**50,000**

Appendix G. Evaluation of Alternative ALD Charge Size Thresholds

This section provides costs, savings, and benefits estimates associated with an alternative policy scenario considering a 500-pound threshold for ALD systems in CR and IPR equipment, rather than 1,500 pounds. This threshold was analyzed because of the significant number of appliances exceeding the leak rate threshold within this equipment size category. All other assumptions are consistent with those discussed in Section **Error! Reference source not found.**.

Error! Reference source not found. summarizes the unit cost assumptions for direct and indirect ALD equipment assuming a 500-pound threshold.

Table G-1: Unit Cost Assumptions for ALD Equipment for 500-pound Threshold

System Size	Material Cost	Labor Hours	Installation Cost	Equipment and Installation Cost	Annualized Equipment and Installation Cost (Years 1-5)	Annual O&M Cost
Direct ALD System						
500–1,500	$7,500	12	$662	$8,160	$2,142	$950
1,500–2,000	$9,000	16	$883	$9,880	$2,594	$1,250
2,000+	$9,850	20	$1,104	$10,950	$2,875	$1,440
Indirect ALD System						
500-1,500	$1,600	6	$330	$1,930	NA	$775
1,500-2,000	$2,850	8	$440	$3,290	NA	$950
2,000+	$2,650	10	$550	$3,200	NA	$1,000

Error! Reference source not found. summarizes compliance costs for each equipment sector and type category associated with a 500-pound ALD threshold for CR and IPR equipment.

Table G-2: Aggregate Compliance Costs by Sector, Equipment Type, and Size for 500-pound ALD Threshold[a]

Sector	Equipment Type	Equipment Size	2025	2030	2040	2050
CC	School & Tour Bus AC	Sub-small	$8,117,200	$8,906,500	$10,134,400	$10,979,000
	Transit Bus AC	Sub-small	$2,871,100	$3,150,300	$3,584,600	$3,883,400
	Passenger Train AC	Sub-small	$437,900	$484,200	$530,700	$574,700
	Chiller	Medium	$12,447,500	$15,028,900	$16,333,100	$17,690,200
		Large	$86,800	$95,400	$111,200	$124,100
CR	Modern Rail Transport	Sub-small	$728,700	$747,100	$799,500	$865,900
	Vintage Rail Transport	Sub-small	$722,700	$274,500	$0	$0
	Condensing Unit	Sub-small	$24,522,400	$26,608,200	$27,242,400	$30,055,100
	Marine Transport	Small	$1,460,400	$1,882,400	$2,395,600	$2,702,700
		Medium	$25,851,900	$22,378,300	$26,730,000	$29,622,700
		Large	$508,900	$400,500	$467,000	$507,500
	Rack	Medium	$113,877,300	$81,787,000	$90,174,500	$97,966,500
		Large	$63,506,400	$45,367,700	$50,016,800	$54,337,800
	Cold Storage	Large	$2,208,200	$488,700	$210,900	$0
IPR	IPR	Medium	$20,460,000	$5,069,000	$2,266,100	$0
		Large	$71,241,900	$14,563,300	$6,741,700	$0
Reporting and Recordkeeping			$11,503,900	$13,002,700	$14,135,000	$15,357,100

[a] Costs are displayed using a 3 percent discount rate.

Total incremental compliance costs associated with the 500-pound ALD threshold scenario are approximately $5.1 billion based on a 3 percent discount rate, discounted back to 2024, as shown in **Error! Reference source not found.**.

Table G-3: Incremental Annual Compliance Costs (2022$) for 500-pound ALD Threshold Scenario

Year	Total Incremental Compliance Costs (3% Discount Rate)	Refrigerant Savings	Total Incremental Compliance Costs Minus Refrigerant Savings (3% Discount Rate)
2025	$374,000,000	$13,800,000	$361,000,000
2026	$295,000,000	$14,000,000	$281,000,000
2027	$311,000,000	$14,300,000	$297,000,000
2028	$330,000,000	$14,500,000	$315,000,000
2029	$343,000,000	$14,600,000	$328,000,000
2030	$255,000,000	$14,700,000	$240,000,000
2031	$257,000,000	$14,700,000	$242,000,000
2032	$258,000,000	$14,800,000	$243,000,000
2033	$260,000,000	$14,800,000	$245,000,000
2034	$261,000,000	$14,700,000	$246,000,000
2035	$261,000,000	$14,500,000	$247,000,000
2036	$262,000,000	$14,200,000	$247,000,000
2037	$263,000,000	$13,900,000	$249,000,000
2038	$263,000,000	$13,700,000	$250,000,000
2039	$264,000,000	$13,400,000	$251,000,000
2040	$265,000,000	$13,100,000	$252,000,000
2041	$266,000,000	$12,700,000	$253,000,000
2042	$266,000,000	$12,400,000	$254,000,000
2043	$267,000,000	$12,100,000	$255,000,000
2044	$267,000,000	$11,700,000	$255,000,000
2045	$268,000,000	$11,400,000	$256,000,000
2046	$269,000,000	$11,200,000	$258,000,000
2047	$270,000,000	$11,000,000	$259,000,000
2048	$272,000,000	$11,000,000	$261,000,000
2049	$273,000,000	$11,000,000	$263,000,000
2050	$276,000,000	$11,100,000	$265,000,000
	Discount Rate	**3%**	**7%**
	NPV	$4,640,000,000	$3,140,000,000
	EAV	$253,000,000	$262,000,000

Total annual savings associated with reduced refrigerant use from the 500-pound ALD threshold scenario are estimated to be $13 million. **Error! Reference source not found.** below shows the annual savings by rule component.

Table G-4: Total Annual Refrigerant Savings in 2025 (2022$) and Combined Annual Cost and Annual Savings with 7% and 3% Discount Rate for 500-pound ALD Threshold Scenario

Rule Component	Annual Refrigerant Savings	Incremental Compliance Costs	Combined Annual Savings and Compliance Costs	Incremental Compliance Costs	Combined Annual Savings and Compliance Costs
		7% Discount Rate		3% Discount Rate	
Leak Repair					
CC (Sub-small, 15-50 lbs.)	-$36,100	$3,054,000	$3,018,000	$1,450,000	$1,414,000
CC (Small, 51-199 lbs.)	$0	$0	$0	$0	$0
CC (Medium, 200-1,999 lbs.)	-$3,184,000	$8,798,000	$5,614,000	$4,210,000	$1,026,000
CC (Large, ≥2,000 lbs.)	-$120,900	$139,000	$18,000	$66,000	-$55,000
CR (Sub-small, 15-50 lbs.)	-$198,400	$3,748,000	$3,549,000	$1,780,000	$1,582,000
CR (Small, 51-199 lbs.)	-$183,500	$244,000	$60,000	$116,000	-$68,000
CR (Medium, 200-1,999 lbs.)	-$2,470,400	$1,997,000	-$474,000	$949,000	-$1,522,000
CR (Large, ≥2,000 lbs.)	-$1,348,900	$549,000	-$800,000	$259,000	-$1,090,000
IPR (Medium, 200-1,999 lbs.)	-$320,300	$152,000	-$168,000	$72,000	-$248,000
IPR (Large, ≥2,000 lbs.)	-$5,925,600	$734,000	-$5,192,000	$348,000	-$5,577,000
Leak Inspection					
CC (Sub-small, 15-50 lbs.)	-	$10,012,000	$10,012,000	$10,012,000	$10,012,000
CC (Small, 51-199 lbs.)	-	$0	$0	$0	$0
CC (Medium, 200-1,999 lbs.)	-	$11,422,000	$11,422,000	$11,422,000	$11,422,000
CC (Large, ≥2,000 lbs.)	-	$141,000	$141,000	$141,000	$141,000
CR (Sub-small, 15-50 lbs.)	-	$24,392,000	$24,392,000	$24,392,000	$24,392,000
CR (Small, 51-199 lbs.)	-	$1,528,000	$1,528,000	$1,528,000	$1,528,000
CR (Medium, 200-1,999 lbs.)	-	$4,762,000	$4,762,000	$4,762,000	$4,762,000
CR (Large, ≥2,000 lbs.)	-	$884,000	$884,000	$884,000	$884,000

Rule Component	Annual Refrigerant Savings	Incremental Compliance Costs	Combined Annual Savings and Compliance Costs	Incremental Compliance Costs	Combined Annual Savings and Compliance Costs
		7% Discount Rate		3% Discount Rate	
IPR (Medium, 200-1,999 lbs.)	-	$345,000	$345,000	$345,000	$345,000
IPR (Large, ≥2,000 lbs.)	-	$993,000	$993,000	$993,000	$993,000
Automatic Leak Detection					
CC	-	-	-	-	-
CR	-	$202,919,000	$202,918,800	$202,919,000	$202,918,800
IPR	-	$96,190,000	$96,189,800	$96,190,000	$96,189,800
Reporting & Recordkeeping					
CC and CR (15-50 lbs.)	-	$6,328,000	$6,328,000	$6,328,000	$6,328,000
CC, CR, and IPR (≥50 lbs.)	-	$5,176,000	$5,176,000	$5,176,000	$5,176,000
Total	**-$13,788,100**	**$384,500,000**	**$370,720,000**	**$374,340,000**	**$360,550,000**

Totals may not sum due to independent rounding.

More detailed results for reporting and recordkeeping associated with the 500-pound ALD threshold scenario are shown in **Error! Reference source not found.** below.

Table G-5: 2025 Incremental Compliance Costs for Recordkeeping and Reporting (2022$) for 500-pound ALD Threshold Scenario

Recordkeeping & Reporting Rule Component	Direct Compliance Costs		
	CC and CR (15-50 pounds)[a]	CC, CR, and IPR (≥50 pounds)	Total
Recordkeeping associated with leak inspection and repair			
Owners/operators of appliances w/charge sizes ≥15 lbs maintain installation records.	$129,000	$284,000	$413,000
Persons servicing appliances w/charge sizes ≥15 lbs provide invoices to appliance owners/operators.	$1,407,000	$1,173,000	$2,580,000
Owners/operators of appliances w/charge sizes ≥15 lbs maintain purchase and service records.	$1,924,000	$1,604,000	$3,528,000
Persons servicing appliances w/charge sizes ≥15 lbs provide leak inspection records	$185,000	$132,000	$317,000
Owners/operators of appliances w/charge sizes ≥15 lbs maintain leak inspection records	$337,000	$240,000	$577,000

Recordkeeping & Reporting Rule Component	Direct Compliance Costs		
	CC and CR (15-50 pounds)[a]	**CC, CR, and IPR (≥50 pounds)**	**Total**
Owners/operators of appliances w/charge sizes ≥15 lbs prepare & submit requests for extensions to 30-day repair timeline	$7,000	$7,000	$14,000
Owners/operators of appliances w/charge sizes ≥15 lbs prepare & submit requests for extensions to 1-year retrofit/repair timeline	$1,000	$1,000	$2,000
Owners/operators of appliances w/charge sizes ≥15 lbs - Develop/Maintain plan to retire/replace or retrofit equipment, as applicable	$1,619,000	$1,154,000	$2,773,000
Owners/operators of HFC appliances to submit requests to cease retrofit/retirement if all leaks are repaired	$5,000	$4,000	$9,000
Owners/operators of appliances w/charge sizes ≥15 lbs maintain records on mothballed equipment	<$200	<$100	<$200
Persons servicing appliances w/charge sizes ≥15 lbs provide reports on the results of verification tests	$185,000	$132,000	$317,000
Owners/operators of appliances w/charge sizes ≥15 lbs - Maintain reports on the results of verification tests	$506,000	$360,000	$866,000
Owners/operators of appliances w/charge sizes ≥15 lbs prepare and submit a report to EPA if excluding purged refrigerants that are destroyed from annual leak rate calculations for the first time	<$100	<$100	<$100
Owners/operators of appliances w/charge sizes ≥50 lbs maintain information on purged/destroyed refrigerant	<$100	<$100	<$100
Owners/operators of appliances submit report to EPA and describe efforts to identify and repair systems that leak 125% or more of the full charge in a 365 day period	$21,000	$15,000	$36,000
Owners/operators maintain records of anything that is reported to EPA.	$1,000	$1,000	$2,000
Owners/operators of direct ALD systems maintain records regarding the annual calibration or audit of the system and any time the ALD system detects a leak.[a]	$0	$68,000	$68,000
Total	**$6,328,000**	**$5,176,000**	**$11,502,000**

Recordkeeping & Reporting Rule Component	Direct Compliance Costs		
	CC and CR (15-50 pounds)[a]	CC, CR, and IPR (≥50 pounds)	Total

Totals may not sum due to independent rounding.
[a] The use of direct ALD monitoring is assumed to provide owners/operators with the information needed to satisfy this requirement (i.e., no burden is assumed for those systems assumed to install direct ALD systems).

The 500-pound ALD threshold scenario is expected to reduce GHG emissions by approximately 4.0 MMTCO2eq in 2025, as shown in

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Table G-6: Annual GHG Emissions Avoided in 2025, 2030, 2040, and 2050 for 500-pound ALD Threshold Scenario

Rule Component	GHG Emissions Avoided ($MTCO_2eq$)			
Leak Repair and Inspection	2025	2030	2040	2050
CC (Sub-small, 15-50 lbs.)[a]	5,900	6,500	7,300	8,000
CC (Small, 51-199 lbs.)	-	-	-	-
CC (Medium, 200-1,999 lbs.)	513,000	480,000	219,000	132,000
CC (Large, ≥2,000 lbs.)	17,900	15,800	12,200	9,300
CR (Sub-small, 15-50 lbs.)	65,000	59,600	45,700	50,400
CR (Small, 51-199 lbs.)	74,700	97,000	124,000	140,000
CR (Medium, 200-1,999 lbs.)	888,000	1,050,000	1,270,000	1,420,000
CR (Large, ≥2,000 lbs.)	551,000	527,000	470,000	443,000
IPR (Medium, 200-1,999 lbs.)	60,000	49,900	22,400	-
IPR (Large, ≥2,000 lbs.)	1,850,000	1,770,000	922,000	-
Total	**4,020,000**	**4,060,000**	**3,090,000**	**2,180,000**

Totals may not sum due to independent rounding.

As subsectors transition from higher-GWP refrigerants to lower-GWP refrigerants, the distribution of refrigerant in use is anticipated to change significantly over the next decades, resulting in different leak repair and inspection benefits for later years. **Error! Reference source not found.** below shows the annual GHG emissions avoided from HFC refrigerants associated with the 500-pound ALD threshold scenario.

Table G-7: Annual GHG Emissions Avoided in Select Years for 500-pound ALD Threshold Scenario

Year	HFC Emissions Avoided ($MTCO_2e$)
2025	4,020,000
2029	4,070,000
2034	3,940,000
2036	3,670,000
2045	2,390,000
2050	2,200,000
Total 2025–2050	**85,400,000**

Appendix H. SBREFA Assumptions and Methodology

This screening analysis finds that the proposed rulemaking can be presumed not to have a ***significant economic impact on a substantial number of small entities (SISNOSE)***.

This section describes the approach and assumptions used to estimate the economic impact on small entities (businesses and governments) associated with the proposed regulatory requirements related to leak repair and inspection, installation and maintenance of ALD systems, and reporting and recordkeeping; the decision matrix used to make the SISNOSE determination; and the aggregated small entities impacts.[46] The proposed rulemaking applies to equipment used across a wide variety of businesses and government entities,[47] including school districts and cities. This analysis first assesses the economic impact to small businesses and small governments separately and then aggregates the impact across both types of entities to make a SISNOSE determination for the proposed rulemaking.

Approach for Estimating the Economic Impact on Small Businesses

The analysis uses a model entity approach to estimate impacts on small businesses for the leak repair, leak inspection, ALD, and recordkeeping and reporting requirements for stationary refrigeration and air conditioning appliances and transit buses[48] containing more than 15 pounds of refrigerant. To estimate costs per small business, assumptions were developed for each industry category affected by the proposed regulatory changes (i.e., the proportion of facilities that would have appliances with refrigerant charges 15 or more pounds) and the type and number of appliances per affected facility and business. Costs per model facility were developed to accurately reflect the range of compliance costs that a given small business owner or operator could experience from leak repair, leak inspection, ALD installation, and reporting and recordkeeping costs. Costs per model facility were then scaled to a model business on both an industry-specific and equipment-specific basis. Therefore, each model business reflects information about the average number of facilities a business has in a given industry category and equipment type (i.e., smaller businesses typically have fewer facilities per business than larger businesses).

The regulation also includes a requirement to send disposable and refillable cylinders back to reclaimers prior to disposal for recovery of the refrigerant heel. Companies that sell and distribute HFCs, in particular refrigerant, will be impacted.

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[46] Costs associated with certain several mobile subsectors (i.e., Modern Rail Transport, Passenger Train AC, Vintage Rail Transport, and Marine Transport) were not considered in this analysis, as it was determined that these equipment types are wholly owned and operated by large entities.

[47] The Regulatory Flexibility Act (RFA) defines small governments as the government of a city, county, town, township, village, school district, or special district with a population less than 50,000 (EPA 2022).

[48] Approximately 10% of transit buses are assumed to be operated by private industry (e.g., charter buses) (APTA 2022).

Model Facility and Small Business Cost Assumptions for Leak Repair and ALD Provisions

The model business approach is built up from the model equipment analysis described in Section 2.2 and model facility assumptions developed for the average number of systems per facility, for each industry category, as summarized in Table H-1**Error! Reference source not found.Error! Reference source not found.**. These assumptions were based on analysis of 2013 data reported under California's RMP, cross-walked with assumptions made by similar analyses (CARB 2009a; Stratus 2009) about equipment use by industry and reconciled with expert judgment.[49]

Table H-1: Average Number of Systems per Facility in Industries Containing Appliances with 15 or More Pounds of HFC Refrigerant

Industry Category	Average Systems per Facility		
	CC	CR	IPR
Agriculture and Crop Support Services	1	2	-
Arts, Entertainment, and Recreation	1	-	
Beverage and Ice Manufacturing	1	-	1
Charter Bus Industry	1		
Durable Goods Wholesalers and Dealers	2	-	-
Educational Services	4	1	-
Food Manufacturing	1	2	-
General Merchandise Stores	1	2	

[49] Within each industry category, it was assumed that small businesses with annual revenue less than $200,000 do not utilize equipment with more than 15 pounds of refrigerant, given that these equipment typically cool larger spaces and equipment costs be cost prohibitive for these businesses (e.g., a typical commercial unitary air conditioning system can cost between $20,000 to $25,000, which would represent up to 25% of total annual revenue for a business with 2 CC units and an annual revenue of $200,000). Similarly, it was assumed that small businesses with revenue less than $500,000 would not utilize equipment with more than 1,500 pounds of refrigerant (i.e., would not have systems that require installation of ALD systems). Thus, these businesses would not have installed equipment affected by leak repair and inspection and ALD provisions of the rulemaking, respectively.

Grocery and Specialty Food Stores	1	2	-
Hospitals	2	-	-
Ice Rinks	1	-	2
Non-durable Goods Wholesalers and Dealers	1	2	-
Non-food Manufacturing	2	-	3
Office Buildings	3	-	-
Other Warehousing, Storage, and Transportation	4	-	-
Refrigerated Warehousing and Storage	1	2	-
Research and Development	2	-	-
Utilities	2	-	-
Warehouse Clubs and Supercenters	1	3	

Potential compliance costs for each model facility were developed to accurately reflect the range of compliance costs that a given small business owner or operator could experience from leak repair, leak inspection, ALD installation, and reporting and recordkeeping requirements. For each business, there are many potential configurations of equipment types, equipment sizes, and repair outcomes that determine compliance costs for stock above the leak rate threshold. Considering these multiple possibilities, "worst case" model facility assumptions were adopted for standard leak repair and extension leak repair outcomes. The "worst case" reflects the possibility that appliances with leak rates above the threshold leak rate are clustered in individual facilities, such that all of the eligible appliances in a single model facility might trigger inspection and repair. Within each facility, it is assumed that multiple units of the same appliance type are maintained in the same way (e.g., if a facility has two CR systems, both appliances are assumed to have similar leak rates), and thus experience the same leak repair outcomes. Model facility scenarios were developed for each industry category based on how many different sizes of appliances the industry is assumed to use within each sector and the expected number of leak repair outcomes. Retrofit outcomes were determined to only occur to a maximum of one piece of equipment per model facility. Each scenario features a different combination of appliance sizes and leak repair outcomes, with likelihood of each leak repair outcome based on estimates in TABLE 3.

Economic impacts to small businesses associated with ALD installation and maintenance were also developed using the model facility approach. Although the number of potential configurations of equipment are lower because CC equipment are exempt from ALD requirements and only CR and IPR equipment with charge sizes greater than 1,500 pounds are impacted, a larger number of facilities are impacted because ALD requirements apply to all new and existing CR and IPR equipment with charge sizes greater than 1,500 pounds.[50]

Expected compliance costs per model facility were estimated by multiplying the (a) unit cost assumptions described in Chapter 3 averaged across all equipment within a given size category for each sector plus the expected reporting and recordkeeping costs per facility, by the (b) model facility configurations for each industry sector. Costs to small businesses were then scaled based on the proportion of facilities-to-businesses for small businesses in each size category of each NAICS code in each industry category. Some small businesses within each NAICS code and industry category, that operate appliances that are subject to the rule (i.e., CC, CR, and IPR equipment containing more than 15 pounds of refrigerant), are not expected to experience any compliance costs. This is because not all systems will leak above the threshold leak rates (see TABLE 2), and therefore do not require leak repair or inspection or the installation of ALD systems.

Small Business Cost Assumptions for Requiring Heel Recovery from Disposable and Refillable Cylinders

The regulation also institutes a requirement to recover refrigerant heels from disposable cylinders (i.e., non-refillable cylinders), which are primarily used to charge and service stationary refrigeration and air-conditioning systems, and refillable cylinders prior to their disposal. Disposable cylinders are specifically manufactured to be single use. These cylinders are charged with refrigerant, sold for use to fill or service equipment, and disposed (EIA 2018). Disposable cylinders are typically discarded with amounts of refrigerants still in the cylinders that will be emitted over time including from amounts commonly referred to as heels. Refillable cylinders can be reused for more than 20 years (National Refrigerants 2021). Upon being emptied by service technicians, refillable cylinders are typically returned to the wholesaler for reuse. As with disposable cylinders, refillable cylinders will not typically be 100 percent empty after use. Service technicians will generally stop using a cylinder once all the liquid-phase gas has been extracted while the vapor-phase gas remains as a heel. When a refillable cylinder is disposed, either from reaching end-of-life or due to damage to the cylinder, the heel would be emitted to the atmosphere unless it is removed.

[50] For the purposes of this screening analysis, facilities experiencing leak repair and inspection costs are separate from facilities experiencing ALD costs.

Small Entities Potentially Subject to Refrigerant Heel Recovery Requirements

The requirement to remove refrigerant heels from cylinders before disposable would directly impact those companies that sell or distribute or repackage refrigerant in such cylinders, as these companies would be required to return their used cylinder to a reclaimer prior to disposal such that the heel can be recovered instead of sending the cylinder directly to a steel recycler for disposal. For this analysis, potentially affected entities are assumed to be producers, importers, exporters, reclaimers, and companies that sell and distribute HFCs (e.g., blenders, repackagers, and wholesalers or distributors of refrigerants).[51] **Error! Reference source not found.** lists the potentially affected industries by NAICS code and the estimated number of small businesses affected.

Table H-2: List of Industries Potentially Affected by the Prohibition of Disposable Cylinders by NAICS Code

NAICS Code	NAICS Industry Description	Size Standard in Millions of Dollars	Size Standard in Number of Employees	Estimated Number of Small Businesses Affected
325120	Industrial Gas Manufacturing		1000	0[a]
562920	Materials Recovery Facilities	22		44[a]
423740	Refrigeration Equipment and Supplies Merchant Wholesalers		100	298[b]
423730	Warm Air Heating and Air-Conditioning Equipment and Supplies Merchant Wholesalers		150	1,028[b]
424690	Other Chemical and Allied Products Merchant Wholesalers		150	2,881[b]

Source: Small Business Size Regulations, 3 CFR Part 121.201 (2023)

[a] Based on known HFC producers and reclaimers.

[b] It was assumed that 50 percent of businesses within these NAICS codes are refrigerant wholesalers and would be directly affected by the requirement to recover refrigerant heels from cylinders prior to disposal. It is also assumed that the remaining 50 percent of businesses could be affected by the prohibition of disposable cylinders such that they are considered within the universe of potentially affected entities but are expected to experience minimal economic impacts.

[51] For the purposes of this analysis, it is conservatively assumed that producers transport refrigerant primarily in containers larger than 30-lbs. cylinders and therefore the total inventory of 4.5 million cylinders was distributed across importers, exporters, reclaimers, and companies that sell and distribute HFCs (e.g., blenders, repackagers, and wholesalers or distributors of refrigerants) defined by the NAICS codes in **Error! Reference source not found.**.

Estimated Economic Impacts of Requiring Refrigerant Heel Removal from Cylinders prior to Disposal

For the purposes of quantifying direct compliance costs for this analysis, it was assumed that producers, importers, exporters, reclaimers, and companies that sell and distribute HFCs currently sell refrigerant using 4.5 million HFC cylinders.52 All direct compliance costs are calculated as the difference between costs and savings currently incurred under the current business-as-usual (BAU) scenario and those estimated to be incurred under the provisions of the rulemaking.

Cost of transport. Refillable cylinders are only marginally heavier than the largest quantity disposable cylinder on the market. For example, a refillable cylinder containing R-410A weighs approximately 42 pounds (i.e., 25 pounds for the gas and 17 pounds for the cylinder) and a standard disposable cylinder HFC-134a is 39 pounds (i.e., 30 pounds for the gas and 9 pounds for the cylinders) (Government of Australia 2021). However, refillable cylinders require additional trips throughout their use cycle compared to a disposable cylinder. Disposable cylinders are assumed to travel from gas producer/filler to the wholesale distributor; wholesale distributor to end user/technician; and end user/technician to steel recycler.

Refillable cylinders are assumed to travel from the gas producer/filler to the wholesale distributor and from the wholesale distributor to the end user/technician. After cylinders are returned to the wholesale distributor, for approximately half of cylinders sold, distributors would send returned refillable cylinders directly to the gas producers, who would then remove the refrigerant heel and store it until a significant amount has accumulated before sending to the reclaimer. The other half are assumed to be sent from the wholesale distributor to the reclaimer and then back to the gas producer/filler.

Transportation costs were updated to account for the distance traveled for each trip and the use of company fleets to transport cylinders based on a CARB (2011) analysis. It is assumed that companies already own or lease the proper vehicle fleet to transport cylinders.

Table H-3 summarizes distances per shipment for disposable and refillable cylinders. Based on the location of chemical production facilities around the United States, located primarily along the East Coast, Midwest, Southern United States, and California, it is assumed that a cylinder would travel an

[52] Industry estimates that refillable cylinders account for between less than 1 percent and 10 percent of all 30-pound cylinders used, with a general assumption that the quantity of refillable cylinders as a percentage of all 30-pound cylinders used is closer to 1 percent (A-Gas 2021, National Refrigerants 2021, Fluorofusion 2021). For the purposes of this analysis, it is assumed that 1 percent of all 30-pound cylinders sold in the United States are refillable.

average of 1,000 miles from producer to the wholesale distributor. As assumed in CARB (2011), the distance between wholesale distributor and end user/technician is assumed to be 25 miles. For the refillable scenario, it is assumed that a distributor is regularly dropping off new refrigerant to their customers and would pick up their empty, refillable cylinders on the same trip (or the end user would drop off their empty cylinders to pick up new ones, such that no additional trip for the return of cylinders is necessary. It is also assumed that the distributor would make the determination whether the refillable cylinder is fit for subsequent reuse or would be sent for disposal. Other distances were also based on CARB (2011).

In the recovery scenario, it was assumed that approximately 50 percent of non-refillable cylinders and refillable cylinders would be returned directly to a reclaimer for heel recovery and 50 percent of cylinders would be returned to the distributor and then to the reclaimer for recovery. Upon recovery of the heel, the reclaimer would send the cylinder for recycling.

Table H-3: Travel Distances for Disposable and Refillable Cylinders Before Disposal

Trip	BAU		Recovery Scenario			
	Disposable	Refillable	Disposable-1[b]	Disposable-2[b]	Refillable-1[b]	Refillable-2[b]
Gas producer/filler to wholesale distributor	1,000	1,000	1,000	1,000	1,000	1,000
Wholesale distributor[a] to end user/technician	25	25	25	25	25	25
End user/technician to steel recycler	75	NA	NA	NA	NA	NA
End user/technician to reclaimer	NA	NA	50	NA	50	NA
End user/technician to distributor	NA	NA	NA	25	NA	25
Distributor to reclaimer	NA	NA	NA	50	NA	50

Wholesale distributor or reclaimer to steel recycler	NA	75	75	75	75	75
Total Miles	**1,100**	**1,100**	**1,150**	**1,175**	**1,150**	**1,175**

[a] The wholesale distributor is assumed to regularly drop off new refrigerant and pick up empty, refillable cylinders on the same trip.
[b] Only assumed for 50 percent of shipped cylinders.

Table H-4 provides additional assumptions related to fuel use and labor associated with transporting cylinders.

Table H-4: Additional Transportation Assumptions

Parameter	Assumption
Average Fuel Efficiency	6 miles per gallon[a]
Diesel Fuel Cost	$4.998/gallon[b]
Average Truck Speed	50 miles per hour[c]
Labor Rate (Truck Transport)	$50.4[d]

[a] ICCT (2015)
[b] U.S. EIA (2023)
[c] CARB (2011)
[d] Labor rate for Heavy and Tractor-Trailer Truck Drivers from Bureau of Labor Statistic's Employer Costs for Employee Compensation – May 2020. Median hourly wages rates were multiplied by a factor of 2.1 to reflect the estimated additional costs for overhead (BLS 2022a).

Transportation costs were then calculated on a per cylinder basis. This analysis conservatively estimates transportation costs on a per cylinder basis assuming a truck could fit approximately 1,120 disposable cylinders or 870 refillable cylinders (CARB 2011). Recent information about cylinder transport indicates that refillable cylinders are typically shipped in metal containers that are approximately the same size as a pallet of disposable cylinders, but because containers for refillable cylinders are more durable and can be stacked higher, they offer improved storage efficiency compared to disposable cylinders (Government of Australia 2021). **Error! Reference source not found.** summarizes the transport cost per cylinder based on the assumptions presented above.

To calculate annual transport costs per small business, it was assumed that a total of 4.5 million cylinders are transported per year under both the BAU scenario and the provisions of the rulemaking. An estimated 1 percent of the 4.5 million cylinder fleet are assumed to be refillable cylinders, of which an estimated 5 percent of are disposed each year to account for the number of refillable cylinders reaching end-of-life annually and to account for any damaged cylinders. The number of cylinders transported before disposal per small business was distributed across businesses in proportion to their annual sales (Census Bureau 2020).

Table H-5: Transportation Assumptions before Disposal per Cylinder

Scenario		Fuel Costs	Labor	Total
BAU	Disposable	$0.82	$0.99	$1.81
	Refillable	$1.05	$1.27	$2.33
Recovery Scenario	Disposable-1[a]	$0.86	$1.04	$1.89
	Disposable-2[a]	$0.87	$1.06	$1.93
	Refillable-1[a]	$1.10	$1.33	$2.43
	Refillable-2[a]	$1.13	$1.36	$2.49

[a] Assumed applicable to 50 percent of cylinders.

Recovered heel. Under the recovery scenario, disposable and refillable cylinders are returned to a reclaimer prior to disposal containing a refrigerant heel that is recovered and sold back into the market. It was assumed that cylinders contain a heel of approximately 0.96 pounds based on CARB (2011) and expert judgment. Recovered refrigerant is assumed to be resold at approximately $4 per pound based on average refrigerant costs applied in EPA (2021a). The total annual savings associated with recovered heel was distributed across businesses in proportion to their assumed number of cylinders (as estimated under previous steps).

Table H-6 summarizes the cost assumptions associated with the requirement to recover the refrigerant heel from Disposable and refillable cylinders prior to disposal.

Table H-6: Cost Assumptions for BAU and Rulemaking from Cylinder Heel Recovery Requirement

Assumption	Cylinder Type	BAU	Rulemaking
Number of Cylinders Disposed	Disposable	4,455,000	4,455,000
	Refillable	45,000	45,000
Average Transport Cost per Cylinder	Disposable	$1.81	$1.91
	Refillable	$2.33	$2.46
Cylinder Heel Amount (lbs.) and Percent of Cylinder	Both	0.96 (4%)	0.96 (4%)
Average Refrigerant Price ($/lbs.)	Both	$4	$4

Costs of Data Entry into Cylinder Tracking ID System. Affected businesses would also experience costs associated with scanning the QR code affixed to cylinders and entering data into the cylinder tracking ID system as they are bought or sold, consistent with the Information Collection Request for this rulemaking. These costs were distributed across businesses in proportion to their total cylinder purchases.

Summary of Economic Impacts. To inform the sales test, economic data about each affected industry—including number of firms by employment and receipts size—was obtained from the U.S. Census Bureau's Statistics of U.S. Businesses. Annualized compliance costs for small businesses in each affected industry were compared to annual sales by firm size, as shown in **Error! Reference source not found.**. As shown, all small businesses are expected to experience a positive economic impact (i.e., cost savings) associated with the requirement to recover heels prior to cylinder disposal.

Table H-7: Summary of Annual Economic Impacts from Cylinder Heel Recovery Requirement on Small Businesses by NAICS Code

Employee Size	Number of Small Businesses Affected	Average Annual Sales per Firm	Assumed Cylinder Fleet per Firm	Annual Cost per Small Business			Total Annual Cost per Small Business	Impact as Percent of Annual Sales
				Average Incremental Annual Transport Costs	Heel Savings	Annual Cost of Data Entry into Cylinder Tracking ID System		
Materials Recovery Facilities (Reclaimers)								
<5	17	$812,953	10	$1	-$36	$4	-$32	-0.004%
5-9	9	$2,324,738	27	$3	-$104	$10	-$90	-0.004%
10-19	7	$3,827,942	45	$5	-$170	$17	-$149	-0.004%
20-99	9	$9,672,086	113	$12	-$431	$43	-$376	-0.004%
100-499	2	$19,182,700	225	$23	-$854	$85	-$746	-0.004%
Refrigeration Equipment and Supplies Merchant Wholesalers								
<5	142	$663,350	23	$2	-$87	$9	-$76	-0.01%
5-9	67	$3,509,805	121	$12	-$461	$46	-$402	-0.01%
10-19	44	$5,826,375	201	$21	-$765	$76	-$668	-0.01%
20-99	45	$22,108,876	763	$79	-$2,902	$290	-$2,534	-0.01%
Warm Air Heating and Air-Conditioning Equipment and Supplies Merchant Wholesalers								

<5	405	$1,174,630	41	$4	-$156	$16	-$136	-0.01%
5-9	214	$3,293,890	115	$12	-$437	$44	-$382	-0.01%
10-19	176	$7,224,339	252	$26	-$959	$96	-$837	-0.01%
20-99	222	$22,987,391	802	$83	-$3,052	$305	-$2,665	-0.01%
100-149	11	$136,390,545	4,761	$490	-$18,107	$1,807	-$15,810	-0.01%
Other Chemical and Allied Products Merchant Wholesalers								
<5	1596	$1,737,181	60	$6	-$230	$23	-$201	-0.01%
5-9	527	$5,067,550	176	$18	-$671	$67	-$586	-0.01%
10-19	361	$12,563,032	437	$45	-$1,664	$166	-$1,453	-0.01%
20-99	356	$28,842,041	1,004	$103	-$3,820	$381	-$3,335	-0.01%
100-149	41	$115,711,086	4,029	$415	-$15,326	$1,530	-$13,381	-0.01%

Approach for Estimating the Economic Impact on Small Governments

This analysis also uses a model entity approach to estimate impacts on small school districts and small governments for the leak repair, leak inspection, and recordkeeping and reporting requirements for school buses and transit buses, respectively.[53]

In the United States, there are approximately 13,085[54] school districts with a total enrollment of 33.1 million students as of 2018 (Urban Institute Education Data Portal 2022) and 482,714 yellow school buses[55] (EPA 2023a). There are approximately 57,006 public transit buses in the United States serving over 174 million people in 3,030 cities as of 2017 (GFOA N.d.). This analysis assumes that each school district utilizes school buses for student transportation, and each city utilizes transit buses for public transportation. Furthermore, although approximately 40% of school buses and 28% of transit buses are contracted, it is assumed that costs associated with the proposed rulemaking would be passed down to the individual school districts and cities (APTA 2022). Therefore, this analysis assumes that every school district and city is potentially impacted by the proposed rulemaking.

Model Facility and Small Government Cost Assumptions

To analyze and estimate the economic impact of the proposed leak repair and inspection provisions on school and transit buses, school districts were grouped into ten groups based on enrollment and transit buses were grouped into thirteen groups based on population. For school districts, the average enrollment, population within the school district, and revenue for the associated local government of each school district were determined for each enrollment size. For cities, the average population and revenue for the associated local government of each city were determined for each population size. Of the ten school enrollment groups, four were defined as small government with an average population of 50,000 or less and represent 12,187 school districts. Of the thirteen city population groups, four were defined as a small government with populations less than 50,000 and represent 2,276 cities.

As noted above, there are approximately 482,714 yellow school buses in use in the United States across 13,085 school districts. Approximately 51% of students ride a school bus as their primary means of

[53] Approximately 90% of transit buses are assumed to be operated by transit agencies (APTA 2022).
[54] 56 school districts have an enrollment of 0 students and were therefore not included in this analysis.
[55] While federal law does not require school buses to be yellow, the National Highway Traffic Safety Administration (NHTSA) provides recommendations to states on transportation safety and operational aspects of school buses. Along with other matters and uniform identifying characteristics, NHTSA recommends that school buses be painted "National School Bus Glossy Yellow".

transportation (USAFacts 2022), which equates to an average of 34 students per school bus. With approximately 51,305 public-owned transit buses, about 5% of the total population utilizes bus transit (Census 2021), which equates to an average of 180 people per bus.

Table H-8 summarizes the average enrollment, population, revenue, and number of school buses per school district within the four small government enrollment groups and the average population, revenue, and number of transit buses per city within the four small government population groups.

Table H-8: School District and City Government Population and Revenue by Enrollment and Population Size

Enrollment Group	Number of Districts	Average Enrollment per District	Average Population per District	Average Revenue per District	Average School Buses per District
School Buses					
0-500	5,524	235	1,875	$4,138,069	3
501-999	2,538	712	5,458	$11,246,957	10
1,000-4,999	3,726	2,244	17,058	$37,866,965	33
5,000-9,999	399[a]	6,930	52,355	$112,226,575	101
	Population Group	**Number of Cities**	**Average Population per City**	**Average Revenue per City**	**Average Transit Buses per City**
Transit Buses					
	10,000-19,999	1,235	14,128	$29,805,843	4
	20,000-29,999	542	24,465	$51,459,646	7
	30,000-39,999	314	34,642	$72,953,140	10
	40,000-49,999	185	44,702	$99,530,151	13

Bolded rows represent a small government school district.
Source: Urban Institute Education Data Portal (2022) and Government Finance Officers Association (n.d.).
a Approximately 59% of the school districts within the 5,000-9,999 enrollment group are below the small government threshold.

Based on the analysis outlined in Appendix A, 193,086 school buses are anticipated to exceed the threshold leak rate and 22,802 transit buses are anticipated to exceed the threshold leak rate, and both are assumed to experience the leak repair outcomes outlined in Table A-2. Total standard leak repairs are distributed to every school district and city in proportion to the number of buses each school district and city uses. Because there are significantly fewer extension and retrofit repairs than standard leak repairs, extension and retrofit repairs are distributed within each group based on total number of buses within each group such that some districts and cities within each enrollment and population size will experience extension and/or retrofit repairs. This analysis therefore assumes that every school district and city experiences at least one standard leak repair, but not every school district and city is assumed to experience an extension or retrofit repair.

Table H-9: Leak Repair Outcomes per School District or City

Enrollment Group	**School Districts**	**Average School Buses per District**	**Total School Buses per Enrollment Group**	**Standard Repairs per School District**	**Extension Repair per Enrollment Group**	**Retrofit Repair per Enrollment Group**
School Buses						
0-500	5,524	3	16,572	1	58	67
501-999	2,538	10	25,380	4	89	102
1,000-4,999	3,726	33	122,958	13	431	495
5,000-9,999	399	101	40,299	40	141	162
Population Group	**Cities**	**Average Transit Buses per City**	**Total Transit Buses per Population Group**	**Standard Repairs per City**	**Extension Repair per City**	**Retrofit Repair per City**
Transit Buses						
10,000-19,999	1,235	4	4,940	2	19	22
20,000-29,999	542	7	3,794	3	15	17
30,000-39,999	314	10	3,140	4	12	14
40,000-49,999	185	13	2,405	6	9	11

To estimate the economic impact of the leak repair and inspection provisions on school buses, four model government scenarios were established to represent various combinations of leak repair outcomes for each school district: standard repair only, standard repair + extension repair, standard repair + retrofit repair, and standard repair + extension repair + retrofit repair.

The four model governments are established based on the lowest number of repair type instances (in this case, extension repairs). It was therefore assumed that 50% of extension and retrofit repairs are experienced by a school district and city in addition to the assumed standard repair(s) for each group (i.e., standard repair + extension repair or standard repair + retrofit) and 50% of extension and retrofit repairs are experienced together by a school district and city in addition to the assumed standard repair(s) for each group (i.e., standard leak repair + extension repair + retrofit repair). The number of school districts and cities affected by each leak repair scenario is summarized in Table H-10.

Table H-10: Number of School Districts and Cities Affected by Leak Repair Scenarios

Enrollment Group	School Districts	Average School Buses per District	Number of School Districts Impacted			
			Standard Repair Only	Standard + Extension Repair	Standard + Retrofit Repair	Standard + Extension + Retrofit Repair
School Buses						
0-500	5,524	3	5,428	29	38	29
501-999	2,538	10	2,392	45	58	45
1,000-4,999	3,726	33	3,016	216	280	216
5,000-9,999	399	101	167	71	92	71
Population Group	**Cities**	**Average Transit Buses per City**	**Number of Cities Impacted**			
			Standard Repair Only	**Standard + Extension Repair**	**Standard + Retrofit Repair**	**Standard + Extension + Retrofit Repair**
Transit Buses						
10,000-19,999	1,235	4	1,204	10	13	10
20,000-29,999	542	7	518	8	10	8
30,000-39,999	314	10	294	6	8	6
40,000-49,999	185	13	170	5	7	5

Cost estimates for each leak repair scenario were applied to each school district and city to evaluate the burden compared to their average revenue (see sections 3.2 and 3.7 for discussion of leak repair, leak inspection, and reporting and recordkeeping cost estimates).

Decision Matrix for Determining Significant Economic Impact on a Substantial Number of Small Entities

This analysis uses the matrix shown in **Error! Reference source not found.** to determine whether this rulemaking would impose a SISNOSE. The economic threshold levels are set conservatively at 1% and 3% of sales, consistent with similar analyses of other Clean Air Act Title VI rules. These thresholds are set conservatively because the rulemaking affects small businesses in a range of different industries, which may have significantly different profit margins and abilities to pass compliance costs along to customers, and a range of small governments with significantly different revenue. Based on this decision matrix, this screening analysis finds that the rulemaking can be presumed to have ***no SISNOSE.***

Table H-11: Decision Matrix for Certifying SISNOSE

Economic Impact	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	Certification Category
Less than 1% for all affected small entities	Any number	Any percent	Presumed No SISNOSE
1% or more for one or more affected small entities	Fewer than 100	Less than 20%	Presumed No SISNOSE
	Fewer than 100	20% or more	Uncertain – No Presumption
	Between 100 and 999	Less than 20%	Presumed No SISNOSE
	Between 100 and 999	20% or more	Uncertain – No Presumption
	1000 or more	Any percent	Uncertain – No Presumption
Greater than 3% for one or more affected small entities	Fewer than 100	Less than 20%	Presumed No SISNOSE
	Fewer than 100	20% or more	Uncertain – No Presumption
	Between 100 and 999	Less than 20%	Uncertain – No Presumption
	Between 100 and 999	20% or more	Presumed Ineligible for Certification
	1000 or more	Any percent	Presumed Ineligible for Certification

Aggregate Small Entities Impacts of Regulatory Changes

As shown in Table H-12**Error! Reference source not found.**, an estimated 165,830 small businesses and 14,463 small governments may be subject to the regulatory actions.

Table H-12: Summary of the Small Entities Impact

Entity	Estimated Number of Small Entities Affected by the Rule
Small Business Industry Type	
Agriculture and Crop Support Services	3,015
Arts, Entertainment, and Recreation	183
Beverage and Ice Manufacturing	424

Entity	Estimated Number of Small Entities Affected by the Rule
Charter Bus Industry	908
Durable Goods Wholesalers and Dealers	575
Educational Services	75
Food manufacturing	3,788
Grocery and Specialty Food Stores	48,556
Hospitals	259
Non-durable Goods Wholesalers and Dealers	2,364
Non-food Manufacturing	43,229
Office Buildings	9,594
Other Warehousing, Storage, and Transportation	44,110
Refrigerated Warehousing and Storage	388
Utilities	4,111
Materials Recovery Facilities (Reclaimers)	44
Refrigeration Equipment and Supplies Merchant Wholesalers	298
Warm Air Heating and Air-Conditioning Equipment and Supplies Merchant Wholesalers	1,028
Other Chemical and Allied Products Merchant Wholesalers	2,881
Small Government Type	
School Districts	12,187
City Government	2,276
Total	**180,293**

Totals may not sum due to independent rounding.

To analyze the economic impacts on small entities against the SISNOSE decision matrix, a "sales test" was applied, which calculates annualized compliance costs as a percentage of annual sales for businesses in each NAICS code by size category and annual revenue for governments. Total economic impact includes incremental compliance costs for leak repair and inspection and ALD installation, as well as compliance costs for reporting and recordkeeping. For industries for which annual sales data were not available through the Economic Census, annual receipts or annual value of shipments[56] was used as a proxy.

[56] Total value of shipments includes the received or receivable net selling values of all products shipped (excluding freight and taxes).

Table H-13 aggregates the estimated economic impacts on small entities, according to the categories set out in the SISNOSE decision matrix and using a 7% discount rate. Using the decision criteria established in **Error! Reference source not found.**, this screening analysis suggests that this rulemaking can be presumed to have no SISNOSE for the following reasons:

- About 72,870 small entities (40.4%) are expected to experience negligible to net positive (i.e., cost-saving) impacts.
- About 106,694 small entities (59.2%) are estimated to incur compliance costs that will be less than 1% of annual sales/revenue.
- About 730 of the approximately 107,422 affected small entities (<0.40%) could incur costs in excess of 1% of annual sales/revenue. Approximately 59 small entities (<0.033%) could incur costs in excess of 3% of annual sales/revenue. These estimates are below the thresholds for a substantial number determination (i.e., between 100 and 999 entities and less than 20% of affected entities).

Table H-13: Aggregated Economic Impacts on Small Entities with 7% Discount Rate

Economic Impact	Entity Type	Number of Small Entities Subject to the Rule and Experiencing Given Economic Impact	Percent of All Small Entities Subject to the Rule
Less than 1% for all affected small entities [a]	Grocery & Specialty Food Stores	48,223	
	Agriculture and Crop Support Services	3,008	
	Utilities	1,308	
	Food Manufacturing	2,328	
	Beverage & Ice Manufacturing	503	
	Non-Food Manufacturing	23,060	
	Refrigerated Warehousing and Storage	437	
	Other Warehousing, Storage, and Transportation	8,487	

	Non-durable Goods Wholesalers and Dealers	2,301	
	Durable Goods Wholesalers and Dealers	161	
	Educational Services	172	
	Hospitals	101	
	Office Buildings	1,927	
	Arts, Entertainment, and Recreation	127	
	Charter Bus Industry	87	
	School Districts	12,187	
	City Government	2,276	
	Total	**106,694**	**59.2%**
1% or more for one or more affected small entities [b]	Grocery & Specialty Food Stores	332	
	Agriculture and Crop Support Services	7	
	Utilities	32	
	Food manufacturing	80	
	Beverage & Ice Manufacturing	9	
	Non-food Manufacturing	113	
	Refrigeration Warehousing & Storage	<5	
	Other Warehousing, Storage, Transportation	46	
	Non-durable Goods	63	
	Durable Goods	7	

	Educational Services	14	
	Office Buildings	19	
	Arts, Entertainment, Rec.	<5	
	Charter Bus Industry	<5	
	Total	**729**	**0.40%**
Greater than 3% for one or more affected small entities [b]	Grocery & Specialty Food Stores	7	
	Agriculture and Crop Support Services	<5	
	Utilities	10	
	Food manufacturing	<5	
	Beverage & Ice Manufacturing	<5	
	Non-food Manufacturing	22	
	Other Warehousing, Storage, Transportation	6	
	Non-durable Goods	6	
	Durable Goods	<5	
	Educational Services	<5	
	Office Buildings	<5	
	Arts, Entertainment, Rec.	<5	
	Total	**59**	**<0.01%**

Totals may not sum due to independent rounding.
[a] Represents small entities affected with an economic impact equal to or less than 1% but greater than 0%. Approximately 72,870 affected small businesses—or 40.4 percent—would be expected to experience negligible to net positive (i.e., cost-saving) impacts.
[b] 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.

Error! Reference source not found. aggregates the estimated economic impacts on small entities, according to the categories set out in the SISNOSE decision matrix and using a 3% discount rate. Using the decision criteria established in **Error! Reference source not found.**, this screening analysis suggests that this rulemaking can be presumed to have no SISNOSE for the following reasons:

- About 72,870 small entities (40.4%) are not expected to incur compliance costs.
- About 106,862 small entities (59.3%) are estimated to incur compliance costs that will be less than 1% of annual sales/revenue.
- About 560 of the approximately 107,422 affected small entities (<0.31%) could incur costs in excess of 1% of annual sales/revenue. Approximately 12 small entities (<0.006%) could incur costs in excess of 3% of annual sales/revenue. These estimates are below the thresholds for a substantial number determination (i.e., between 100 and 999 entities and less than 20% of affected entities).

Table H-14: Aggregated Economic Impacts on Small Entities with 3% Discount Rate

Economic Impact	Entity Type	Number of Small Entities Subject to the Rule and Experiencing Given Economic Impact	Percent of All Small Entities Subject to the Rule
Less than 1% for all affected small entities [a]	Grocery & Specialty Food Stores	48,300	
	Agriculture and Crop Support Services	3,009	
	Utilities	1,314	
	Food Manufacturing	2,349	
	Beverage & Ice Manufacturing	506	
	Non-Food Manufacturing	23,096	
	Refrigerated Warehousing and Storage	437	
	Other Warehousing, Storage, and Transportation	8,500	

	Non-durable Goods Wholesalers and Dealers	2,309	
	Durable Goods Wholesalers and Dealers	161	
	Educational Services	173	
	Hospitals	101	
	Office Buildings	1,929	
	Arts, Entertainment, and Recreation	128	
	Charter Bus Industry	87	
	School Districts	12,187	
	City Government	2,276	
	Total	**106,862**	**59.3%**
1% or more for one or more affected small entities [b]	Grocery & Specialty Food Stores	256	
	Agriculture and Crop Support Services	6	
	Utilities	26	
	Food manufacturing	58	
	Beverage & Ice Manufacturing	7	
	Non-food Manufacturing	77	
	Refrigeration Warehousing & Storage	<5	
	Other Warehousing, Storage, Transportation	34	
	Non-durable Goods	55	
	Durable Goods	7	

	Educational Services	12	
	Office Buildings	17	
	Arts, Entertainment, Rec.	<5	
	Charter Bus Industry	<5	
	Total	**560**	**0.31%**
3% or more for one or more affected small entities [b]	Utilities	9	
	Food manufacturing	<5	
	Non-durable Goods	<5	
	Durable Goods	<5	
	Office Buildings	<5	
	Total	**12**	**<0.01%**

Totals may not sum due to independent rounding.
[a] Represents small entities affected with an economic impact equal to or less than 1% but greater than 0%. Approximately 72,870 affected small businesses—or 40.4 percent—would be expected to experience negligible to net positive (i.e., cost-saving) impacts.
[b] 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 I. NAICS Classification for Leak Repair Requirements

Table I-1: NAICS Codes Included in the Leak Repair Analysis

Sector Description	NAICS Category	NAICS Code	NAICS Code Definition
Agriculture and Crop Support Activities	Support Activities For Agriculture and Forestry (115)	115112	Soil Preparation, Planting, and Cultivating
		115113	Crop Harvesting, Primarily By Machine
		115114	Postharvest Crop Activities (Except Cotton Ginning)
Arts, Entertainment, and Recreation	Arts, Entertainment, and Recreation (71)	711310	Promoters Of Performing Arts, Sports, and Similar Events With Facilities
		713940	Fitness and Recreational Sports Centers
Beverage and Ice Manufacturing	Beverage Manufacturing (312)	312111	Soft Drink Manufacturing
		312112	Bottled Water Manufacturing
		312113	Ice Manufacturing
		312120	Breweries
		312130	Wineries
Durable Goods Wholesalers and Dealers	Merchant Wholesalers - Durable Goods (423)	423410	Photographic Equipment and Supplies Merchant Wholesalers
		423740	Refrigeration Equipment and Supplies Merchant Wholesalers
		423990	Other Miscellaneous Durable Goods Merchant Wholesalers
Educational Services	Educational Services (611)	611110	Elementary and Secondary Schools
		611210	Junior Colleges
		611310	Colleges, Universities, and Professional Schools
Food Manufacturing	Food Manufacturing (311)	311111	Dog and Cat Food Manufacturing
		311119	Other Animal Food Manufacturing
		311211	Flour Milling
		311212	Rice Milling
		311213	Malt Manufacturing
		311221	Wet Corn Milling
		311224	Soybean and Other Oilseed Processing
		311225	Fats and Oils Refining and Blending

Sector Description	NAICS Category	NAICS Code	NAICS Code Definition
		311230	Breakfast Cereal Manufacturing
		311313	Beet Sugar Manufacturing
		311314	Cane Sugar Manufacturing
		311340	Nonchocolate Confectionery Manufacturing
		311351	Chocolate and Confectionery Manufacturing From Cacao Beans
		311352	Confectionery Manufacturing From Purchased Chocolate
		311411	Frozen Fruit, Juice, and Vegetable Manufacturing
		311412	Frozen Specialty Food Manufacturing
		311421	Fruit and Vegetable Canning
		311422	Specialty Canning
		311423	Dried and Dehydrated Food Manufacturing
		311511	Fluid Milk Manufacturing
		311512	Creamery Butter Manufacturing
		311513	Cheese Manufacturing
		311514	Dry, Condensed, and Evaporated Dairy Product Manufacturing
		311520	Ice Cream and Frozen Dessert Manufacturing
		311611	Animal (Except Poultry) Slaughtering
		311612	Meat Processed From Carcasses
		311613	Rendering and Meat Byproduct Processing
		311615	Poultry Processing
		311710	Seafood Product Preparation and Packaging
		311811	Retail Bakeries
		311812	Commercial Bakeries
		311813	Frozen Cakes, Pies, and Other Pastries Manufacturing
		311821	Cookie and Cracker Manufacturing
		311824	Dry Pasta, Dough, and Flour Mixes Manufacturing From Purchased Flour
		311830	Tortilla Manufacturing
		311911	Roasted Nuts and Peanut Butter Manufacturing
		311919	Other Snack Food Manufacturing

Sector Description	NAICS Category	NAICS Code	NAICS Code Definition
		311920	Coffee and Tea Manufacturing
		311930	Flavoring Syrup and Concentrate Manufacturing
		311941	Mayonnaise, Dressing, and Other Prepared Sauce Manufacturing
		311942	Spice and Extract Manufacturing
		311991	Perishable Prepared Food Manufacturing
		311999	All Other Miscellaneous Food Manufacturing
General Merchandise Stores	General Merchandise Stores (452)	452210	Department Stores
		452319	All Other General Merchandise Stores
	All Other Miscellaneous Store Retailers (Except Tobacco Stores) (453998)	453998	All Other Miscellaneous Store Retailers (Except Tobacco Stores)
Grocery and Specialty Food Stores	Grocery and Convenience Retailers (4451)	445110	Supermarkets and Other Grocery (Except Convenience) Stores
		445131	Convenience Retailers
	Specialty Food Stores (4452)	445240	Meat Markets
		445230	Fruit and Vegetable Markets
		445299	All Other Specialty Food Stores
	Food Service Contractors (72231)	722310	Food Service Contractors
Hospitals	Hospitals (622)	622110	General Medical and Surgical Hospitals
Mining, Quarrying, and Oil and Gas Extraction	Oil and Gas Extraction (211)	211120	Crude Petroleum Extraction
		211130	Natural Gas Extraction
Non-Durable Goods Wholesalers and Dealers	Merchant Wholesalers – Non-Durable Goods (424)	424210	Drugs and Druggists' Sundries Merchant Wholesalers
		424410	General Line Grocery Merchant Wholesalers
		424420	Packaged Frozen Food Merchant Wholesalers
		424430	Dairy Product (Except Dried Or Canned) Merchant Wholesalers
		424440	Poultry and Poultry Product Merchant Wholesalers

Sector Description	NAICS Category	NAICS Code	NAICS Code Definition
		424460	Fish and Seafood Merchant Wholesalers
		424470	Meat and Meat Product Merchant Wholesalers
		424480	Fresh Fruit and Vegetable Merchant Wholesalers
		424490	Other Grocery and Related Products Merchant Wholesalers
		424590	Other Farm Product Raw Material Merchant Wholesalers
		424710	Petroleum Bulk Stations and Terminals
		424810	Beer and Ale Merchant Wholesalers
		424930	Flower, Nursery Stock, and Florists' Supplies Merchant Wholesalers
Non-Food Manufacturing	Paper Manufacturing (322)	322121	Paper (Except Newsprint) Mills
		322211	Corrugated and Solid Fiber Box Manufacturing
		322220	Paper Bag and Coated and Treated Paper Manufacturing
	Printing and Related Support Activities (323)	323111	Commercial Printing (Except Screen and Books)
	Petroleum Manufacturing (324)	324110	Petroleum Refineries
	Chemical Manufacturing (325)	325120	Industrial Gas Manufacturing
		325180	Other Basic Inorganic Chemical Manufacturing
		325211	Plastics Material and Resin Manufacturing
		325320	Pesticide and Other Agricultural Chemical Manufacturing
		325620	Toilet Preparation Manufacturing
		325991	Custom Compounding Of Purchased Resins
		325998	All Other Miscellaneous Chemical Product and Preparation Manufacturing
	Pharmaceutical Manufacturing (3254)	325412	Pharmaceutical Preparation Manufacturing
		325413	In-Vitro Diagnostic Substance Manufacturing
		325414	Biological Product (Except Diagnostic) Manufacturing
	Plastics and Rubber Manufacturing (326)	326122	Plastics Pipe and Pipe Fitting Manufacturing
		326140	Polystyrene Foam Product Manufacturing
		326160	Plastics Bottle Manufacturing

Sector Description	NAICS Category	NAICS Code	NAICS Code Definition
		326199	All Other Plastics Product Manufacturing
		326211	Tire Manufacturing (Except Retreading)
	Metals Manufacturing (332)	332431	Metal Can Manufacturing
		332812	Metal Coating, Engraving (Except Jewelry and Silverware), and Allied Services To Manufacturers
		332813	Electroplating, Plating, Polishing, Anodizing, and Coloring
	Machinery Manufacturing (333)	333241	Food Product Machinery Manufacturing
		333242	Semiconductor Machinery Manufacturing
		333415	Air-Conditioning and Warm Air Heating Equipment and Commercial and Industrial Refrigeration Equipment Manufacturing
		333611	Turbine and Turbine Generator Set Units Manufacturing
	Computer and Electronic Product Manufacturing (334)	334112	Computer Storage Device Manufacturing
		334419	Other Electronic Component Manufacturing
		334413	Semiconductor and Related Device Manufacturing
		334419	Other Electric Component Manufacturing
		334510	Electromedical and Electrotherapeutic Apparatus Manufacturing
		334515	Instrument Manufacturing For Measuring and Testing Electricity and Electrical Signals
		334516	Analytical Laboratory Instrument Manufacturing
		334613	Blank Magnetic and Optical Recording Media Manufacturing
	Transportation Equipment Manufacturing (336)	336411	Aircraft Manufacturing
		336415	Guided Missile and Space Vehicle Propulsion Unit and Propulsion Unit Parts Manufacturing
	Medical Equipment and Supplies Manufacturing (3391)	339112	Surgical and Medical Instrument Manufacturing
	Miscellaneous Manufacturing (339999)	339999	All Other Miscellaneous Manufacturing

Sector Description	NAICS Category	NAICS Code	NAICS Code Definition
Office Buildings	Publishing Industries (Except Internet) (511)	511110	Newspaper Publishers
		511120	Periodical Publishers
		511130	Book Publishers
		511140	Directory and Mailing List Publishers
		511191	Greeting Card Publishers
		511199	All Other Publishers
		511210	Software Publishers
	Motion Picture and Video Industries (512)	512110	Motion Picture and Video Production
		512120	Motion Picture and Video Distribution
		512131	Motion Picture Theaters (Except Drive-Ins)
		512132	Drive-In Motion Picture Theaters
		512191	Teleproduction and Other Postproduction Services
		512199	Other Motion Picture and Video Industries
		512250	Record Production and Distribution
		512230	Music Publishers
		512240	Sound Recording Studios
		512290	Other Sound Recording Industries
	Broadcasting (515)	515111	Radio Networks
		515112	Radio Stations
		515120	Television Broadcasting
		515210	Cable and Other Subscription Programming
	Telecommunications (517)	517311	Wired Telecommunications Carriers
		517312	Wireless Telecommunications Carriers (Except Satellite)
		517410	Satellite Telecommunications
		51791	Other Telecommunications
	Data Processing, Hosting, and Related Services (518)	518210	Data Processing, Hosting, and Related Services
	Libraries and Archives (519)	519120	Libraries and Archives
		522220	Sales Financing
		522291	Consumer Lending

Sector Description	NAICS Category	NAICS Code	NAICS Code Definition
	Credit Intermediation and Related Activities (522)	522292	Real Estate Credit
		522293	International Trade Financing
		522294	Secondary Market Financing
		522298	All Other Nondepository Credit Intermediation
		522310	Mortgage and Nonmortgage Loan Brokers
		522320	Financial Transactions Processing, Reserve, and Clearinghouse Activities
		522390	Other Activities Related To Credit Intermediation
	Insurance Carriers (524)	524113	Direct Life Insurance Carriers
		524114	Direct Health and Medical Insurance Carriers
		524126	Direct Property and Casualty Insurance Carriers
		524127	Direct Title Insurance Carriers
		524128	Other Direct Insurance (Except Life, Health, and Medical) Carriers
		524130	Reinsurance Carriers
		524210	Insurance Agencies and Brokerages
		524291	Claims Adjusting
		524292	Third Party Administration Of Insurance and Pension Funds
		524298	All Other Insurance Related Activities
	Real Estate (531)	531110	Lessors Of Residential Buildings and Dwellings
		531120	Lessors Of Nonresidential Buildings (Except Miniwarehouses)
		531130	Lessors Of Miniwarehouses and Self-Storage Units
		531190	Lessors Of Other Real Estate Property
		531210	Offices Of Real Estate Agents and Brokers
		531311	Residential Property Managers
		531312	Nonresidential Property Managers
		531320	Offices Of Real Estate Appraisers
		531390	Other Activities Related To Real Estate
		541110	Offices Of Lawyers
		541191	Title Abstract and Settlement Offices

Sector Description	NAICS Category	NAICS Code	NAICS Code Definition
	Professional, Scientific, and Technical Services (541)	541199	All Other Legal Services
		541211	Offices Of Certified Public Accountants
		541213	Tax Preparation Services
		541214	Payroll Services
		541219	Other Accounting Services
		541310	Architectural Services
		541320	Landscape Architectural Services
		541330	Engineering Services
		541340	Drafting Services
		541350	Building Inspection Services
		541360	Geophysical Surveying and Mapping Services
		541370	Surveying and Mapping (Except Geophysical) Services
		541380	Testing Laboratories
		541410	Interior Design Services
		541420	Industrial Design Services
		541430	Graphic Design Services
		541490	Other Specialized Design Services
		541511	Custom Computer Programming Services
		541512	Computer Systems Design Services
		541513	Computer Facilities Management Services
		541519	Other Computer Related Services
		541611	Administrative Management and General Management Consulting Services
		541612	Human Resources Consulting Services
		541613	Marketing Consulting Services
		541614	Process, Physical Distribution and Logistics Consulting Services
		541618	Other Management Consulting Services
		541620	Environmental Consulting Services
		541690	Other Scientific and Technical Consulting Services
		54171	Research and Development In The Physical, Engineering, and Life Sciences

Sector Description	NAICS Category	NAICS Code	NAICS Code Definition
		541720	Research and Development In The Social Sciences and Humanities
		541810	Advertising Agencies
		541820	Public Relations Agencies
		541830	Media Buying Agencies
		541840	Media Representatives
		541850	Outdoor Advertising
		541860	Direct Mail Advertising
		541870	Advertising Material Distribution Services
		541890	Other Services Related To Advertising
		541910	Marketing Research and Public Opinion Polling
		541921	Photography Studios, Portrait
		541922	Commercial Photography
		541930	Translation and Interpretation Services
		541940	Veterinary Services
		541990	All Other Professional, Scientific and Technical Services
	Management Of Companies and Enterprises (551)	551111	Offices Of Bank Holding Companies
		551112	Offices Of Other Holding Companies
	Administrative and Support Services (561)	561110	Office Administrative Services
		561210	Facilities Support Services
		56131	Employment Placement Agencies
		561320	Temporary Help Services
		561330	Professional Employer Organizations
		561410	Document Preparation Services
		561421	Telephone Answering Services
		561422	Telemarketing Bureaus and Other Contact Centers
		561431	Private Mail Centers
		561439	Other Business Service Centers (Including Copy Shops)
		561440	Collection Agencies
		561450	Credit Bureaus
		561491	Repossession Services

Sector Description	NAICS Category	NAICS Code	NAICS Code Definition
		561492	Court Reporting and Stenotype Services
		561499	All Other Business Support Services
		561510	Travel Agencies
		561520	Tour Operators
		561591	Convention and Visitors Bureaus
		561599	All Other Travel Arrangement and Reservation Services
		561611	Investigation Services
		561612	Security Guards and Patrol Services
		561613	Armored Car Services
		561621	Security Systems Services (Except Locksmiths)
		561622	Locksmiths
		561710	Exterminating and Pest Control Services
		561720	Janitorial Services
		561730	Landscaping Services
		561740	Carpet and Upholstery Cleaning Services
		561790	Other Services To Buildings and Dwellings
		561910	Packaging and Labeling Services
		561920	Convention and Trade Show Organizers
		561990	All Other Support Services
	Museums, Historical Sites and Similar Institutions (712)	712110	Museums
		712130	Zoos and Botanical Gardens
	Accommodation (721)	721110	Hotels (Except Casino Hotels) and Motels
		721120	Casino Hotels
	Special Food Services (7223)	722320	Mobile Food Services
	Drinking Places (Alcoholic Beverages) (7224)	722410	Drinking Places (Alcoholic Beverages)
	Restaurants and Other Eating Places (7225)	722511	Full-Service Restaurants
		722513	Limited-Service Restaurants
		722514	Cafeterias, Grill Buffets, and Buffets

Sector Description	NAICS Category	NAICS Code	NAICS Code Definition
		722515	Snack and Nonalcoholic Beverage Bars
	Religious, Grantmaking, Civic, Professional, and Similar Organizations (813)	813110	Religious Organizations
		813211	Grantmaking Foundations
		813212	Voluntary Health Organizations
		813219	Other Grantmaking and Giving Services
		813311	Human Rights Organizations
		813312	Environment, Conservation and Wildlife Organizations
		813319	Other Social Advocacy Organizations
		813410	Civic and Social Organizations
		813910	Business Associations
		813920	Professional Organizations
		813930	Labor Unions and Similar Labor Organizations
		813940	Political Organizations
		813990	Other Similar Organizations (Except Business, Professional, Labor, and Political Organizations)
	Public Administration	92	Public Administration
Other Warehousing, Storage, and Transportation	Transportation and Warehousing (48)	484220	Specialized Freight (Except Used Goods) Trucking, Local
		488119	Other Airport Operations
		488510	Freight Transportation Arrangement
		488991	Packing and Crating
	Scheduled Air Transportation (4811)	481112	Scheduled Freight Air Transportation
	Rail Transportation (482)	482111	Line-Haul Railroads
		482112	Short Line Railroads
	Water Transportation (483)	483111	Deep Sea Freight Transportation
		483113	Coastal and Great Lakes Freight Transportation
		483211	Inland Water Freight Transportation
	Truck Transportation (484)	484110	General Freight Trucking, Local
		484121	General Freight Trucking, Long-Distance, Truckload
		484122	General Freight Trucking, Long-Distance, Less Than Truckload

Sector Description	NAICS Category	NAICS Code	NAICS Code Definition
		484220	Specialized Freight (except Used Goods) Trucking, Local
		484230	Specialized Freight (except Used Goods) Trucking, Long-Distance
	Warehousing and Storage (4931)	493110	General Warehousing and Storage
		493130	Farm Product Warehousing and Storage
		493190	Other Warehousing and Storage
Refrigerated Warehousing and Storage	Refrigerated Warehousing and Storage (49312)	493120	Refrigerated Warehousing and Storage
Research and Development	Research and Development (5417)	54171	Research and Development In The Physical, Engineering and Life Sciences
Retail Trade	Gasoline Stations and Fuel Dealers (457)	457110	Gasoline Stations with Convenience Stores
Utilities	Utilities (221)	221111	Hydroelectric Power Generation
		221112	Fossil Fuel Electric Power Generation
		221113	Nuclear Electric Power Generation
		221114	Solar Electric Power Generation
		221115	Wind Electric Power Generation
		221116	Geothermal Electric Power Generation
		221117	Biomass Electric Power Generation
		221118	Other Electric Power Generation
		221121	Electric Bulk Power Transmission and Control
		221122	Electric Power Distribution
		221210	Natural Gas Distribution
		221310	Water Supply and Irrigation Systems
		221320	Sewage Treatment Facilities
		221330	Steam and Air-Conditioning Supply
Warehouse Clubs and Supercenters	Warehouse Clubs and Supercenters (45231)	452311	Warehouse Clubs and Supercenters

Appendix J. Annual SC-HFC Estimates

Note that the tables in this appendix are replicated from Appendix E in the Allocation Framework Rule RIA.

Table J-1: SC-HFC-32 (2020$)

	Discount rate and statistic			
Year	**2.5%**	**3%**	**3% 95th Percentile**	**5%**
2020	49786.59	38382.85	101492.44	18352.27
2021	51413.109	39762.257	105300.205	19177.965
2022	53039.625	41141.666	109107.972	20003.655
2023	54666.141	42521.076	112915.739	20829.346
2024	56292.657	43900.486	116723.505	21655.036
2025	57919.173	45279.895	120531.272	22480.727
2026	59668.379	46770.953	124530.702	23384.736
2027	61417.586	48262.010	128530.133	24288.746
2028	63166.793	49753.068	132529.563	25192.755
2029	64916.000	51244.125	136528.993	26096.764
2030	66665.207	52735.183	140528.424	27000.774
2031	68704.221	54500.880	145708.294	28120.592
2032	70743.235	56266.578	150888.165	29240.411
2033	72782.249	58032.275	156068.035	30360.229
2034	74821.262	59797.972	161247.906	31480.048
2035	76860.276	61563.670	166427.777	32599.866
2036	79039.580	63453.666	171852.464	33805.174
2037	81218.884	65343.662	177277.151	35010.483
2038	83398.188	67233.659	182701.838	36215.792
2039	85577.491	69123.655	188126.525	37421.100
2040	87756.795	71013.652	193551.212	38626.409
2041	90054.034	73050.354	199639.692	40012.789
2042	92351.273	75087.056	205728.172	41399.170
2043	94648.512	77123.758	211816.651	42785.551
2044	96945.751	79160.460	217905.131	44171.931
2045	99242.990	81197.162	223993.611	45558.312
2046	101685.333	83363.003	229987.399	47034.247
2047	104127.677	85528.844	235981.188	48510.182
2048	106570.020	87694.685	241974.976	49986.118
2049	109012.364	89860.526	247968.764	51462.053

Table J-2: SC-HFC-125 (2020$)

	Discount rate and statistic			
Year	**2.5%**	**3%**	**3% 95th Percentile**	**5%**
2020	287355.72	210911.81	551978.95	82898.26
2021	294887.556	217085.503	569594.501	86120.505
2022	302419.397	223259.193	587210.048	89342.751
2023	309951.238	229432.882	604825.595	92564.996
2024	317483.079	235606.572	622441.142	95787.241
2025	325014.920	241780.261	640056.689	99009.487
2026	333092.365	248424.768	657741.554	102515.118
2027	341169.809	255069.275	675426.418	106020.750
2028	349247.254	261713.782	693111.283	109526.382
2029	357324.698	268358.289	710796.148	113032.013
2030	365402.142	275002.796	728481.012	116537.645
2031	373919.994	282163.781	748470.546	120583.985
2032	382437.846	289324.765	768460.080	124630.326
2033	390955.698	296485.750	788449.614	128676.666
2034	399473.550	303646.735	808439.148	132723.006
2035	407991.402	310807.719	828428.682	136769.347
2036	417251.781	318564.552	849636.684	141137.117
2037	426512.159	326321.385	870844.685	145504.888
2038	435772.537	334078.219	892052.687	149872.658
2039	445032.916	341835.052	913260.688	154240.429
2040	454293.294	349591.885	934468.690	158608.199
2041	463371.229	357367.866	955473.401	163321.348
2042	472449.163	365143.847	976478.111	168034.498
2043	481527.097	372919.828	997482.822	172747.647
2044	490605.032	380695.809	1018487.533	177460.797
2045	499682.966	388471.790	1039492.244	182173.946
2046	509191.467	396671.327	1060081.206	187192.272
2047	518699.968	404870.864	1080670.168	192210.597
2048	528208.468	413070.400	1101259.130	197228.922
2049	537716.969	421269.937	1121848.092	202247.248
2050	547225.470	429469.474	1142437.054	207265.573

Table J-3: SC-HFC-134a (2020$)

	Discount rate and statistic			
Year	2.5%	3%	3% 95th Percentile	5%
2020	115195.66	87119.97	228428.24	38251.06
2021	118631.241	89985.780	236470.182	39855.749
2022	122066.820	92851.589	244512.121	41460.442
2023	125502.399	95717.398	252554.059	43065.136
2024	128937.977	98583.206	260595.998	44669.829
2025	132373.556	101449.015	268637.937	46274.522
2026	136095.427	104560.437	277134.079	48030.441
2027	139817.297	107671.858	285630.222	49786.361
2028	143539.168	110783.280	294126.365	51542.280
2029	147261.038	113894.701	302622.507	53298.200
2030	150982.909	117006.122	311118.650	55054.119
2031	155005.633	120437.385	320909.232	57112.544
2032	159028.356	123868.648	330699.814	59170.968
2033	163051.080	127299.910	340490.396	61229.393
2034	167073.804	130731.173	350280.978	63287.817
2035	171096.528	134162.436	360071.560	65346.242
2036	175389.925	137836.695	370127.217	67566.620
2037	179683.323	141510.954	380182.874	69786.999
2038	183976.720	145185.214	390238.532	72007.377
2039	188270.117	148859.473	400294.189	74227.755
2040	192563.514	152533.732	410349.846	76448.134
2041	196659.573	156123.295	419827.206	78783.486
2042	200755.632	159712.859	429304.565	81118.839
2043	204851.691	163302.422	438781.925	83454.191
2044	208947.750	166891.985	448259.285	85789.543
2045	213043.809	170481.549	457736.644	88124.896
2046	217389.754	174299.885	467468.878	90619.705
2047	221735.699	178118.221	477201.111	93114.514
2048	226081.644	181936.558	486933.344	95609.324
2049	230427.590	185754.894	496665.577	98104.133
2050	234773.535	189573.230	506397.811	100598.942

Table J-4: SC-HFC-143a (2020$)

	Discount rate and statistic			
Year	**2.5%**	**3%**	**3% 95th Percentile**	**5%**
2020	376193.35	267248.70	699659.97	94760.56
2021	385135.835	274417.932	720658.392	98266.435
2022	394078.320	281587.166	741656.813	101772.315
2023	403020.806	288756.399	762655.234	105278.195
2024	411963.291	295925.632	783653.655	108784.074
2025	420905.777	303094.866	804652.076	112289.954
2026	430387.114	310744.202	824860.325	116084.243
2027	439868.451	318393.538	845068.575	119878.532
2028	449349.789	326042.873	865276.824	123672.821
2029	458831.126	333692.209	885485.074	127467.109
2030	468312.464	341341.545	905693.323	131261.398
2031	478233.222	349525.185	927712.023	135636.429
2032	488153.980	357708.824	949730.723	140011.459
2033	498074.738	365892.464	971749.423	144386.489
2034	507995.497	374076.103	993768.122	148761.520
2035	517916.255	382259.743	1015786.822	153136.550
2036	528472.557	390986.280	1038786.095	157824.770
2037	539028.859	399712.818	1061785.367	162512.990
2038	549585.161	408439.355	1084784.640	167201.210
2039	560141.463	417165.892	1107783.912	171889.431
2040	570697.765	425892.430	1130783.185	176577.651
2041	581211.345	434775.654	1155302.921	181741.799
2042	591724.925	443658.878	1179822.656	186905.946
2043	602238.506	452542.102	1204342.392	192070.094
2044	612752.086	461425.325	1228862.128	197234.242
2045	623265.667	470308.549	1253381.863	202398.390
2046	634393.420	479730.705	1279066.864	207892.147
2047	645521.173	489152.860	1304751.864	213385.904
2048	656648.926	498575.015	1330436.864	218879.662
2049	667776.679	507997.171	1356121.864	224373.419
2050	678904.432	517419.326	1381806.865	229867.176

Table J-5: SC-HFC-152a (2020$)

Year	Discount rate and statistic			
	2.5%	3%	3% 95th Percentile	5%
2020	6928.87	5359.89	14161.65	2624.61
2021	7156.181	5553.929	14701.064	2743.788
2022	7383.489	5747.968	15240.479	2862.965
2023	7610.797	5942.007	15779.895	2982.142
2024	7838.105	6136.046	16319.310	3101.319
2025	8065.412	6330.085	16858.726	3220.497
2026	8311.446	6540.784	17413.200	3351.178
2027	8557.479	6751.482	17967.675	3481.860
2028	8803.513	6962.181	18522.149	3612.542
2029	9049.546	7172.879	19076.624	3743.223
2030	9295.580	7383.578	19631.099	3873.905
2031	9585.902	7636.208	20372.275	4037.234
2032	9876.225	7888.838	21113.452	4200.563
2033	10166.548	8141.468	21854.629	4363.891
2034	10456.871	8394.098	22595.806	4527.220
2035	10747.194	8646.728	23336.983	4690.548
2036	11057.865	8917.251	24105.852	4866.255
2037	11368.537	9187.774	24874.721	5041.962
2038	11679.209	9458.297	25643.590	5217.668
2039	11989.880	9728.820	26412.458	5393.375
2040	12300.552	9999.343	27181.327	5569.081
2041	12670.904	10326.176	28217.415	5790.383
2042	13041.256	10653.009	29253.503	6011.685
2043	13411.608	10979.842	30289.591	6232.987
2044	13781.960	11306.676	31325.678	6454.288
2045	14152.312	11633.509	32361.766	6675.590
2046	14542.565	11978.535	33387.545	6909.980
2047	14932.817	12323.562	34413.324	7144.371
2048	15323.070	12668.589	35439.104	7378.761
2049	15713.322	13013.615	36464.883	7613.151
2050	16103.575	13358.642	37490.662	7847.542

Table J-6: SC-HFC-227ea (2020$)

Year	Discount rate and statistic

	2.5%	3%	3% 95th Percentile	5%
2020	265356.49	193089.64	506009.35	73736.77
2021	272110.248	198595.466	521308.516	76559.579
2022	278864.004	204101.296	536607.681	79382.390
2023	285617.761	209607.126	551906.846	82205.201
2024	292371.518	215112.956	567206.011	85028.012
2025	299125.275	220618.786	582505.176	87850.823
2026	306344.044	226530.215	598382.520	90917.832
2027	313562.813	232441.643	614259.863	93984.842
2028	320781.582	238353.072	630137.207	97051.852
2029	328000.351	244264.500	646014.550	100118.861
2030	335219.120	250175.928	661891.893	103185.871
2031	342806.814	256528.702	679511.654	106723.214
2032	350394.508	262881.476	697131.415	110260.557
2033	357982.202	269234.249	714751.177	113797.900
2034	365569.896	275587.023	732370.938	117335.243
2035	373157.590	281939.796	749990.699	120872.586
2036	381305.447	288757.900	768267.650	124675.878
2037	389453.303	295576.004	786544.602	128479.170
2038	397601.160	302394.107	804821.553	132282.462
2039	405749.017	309212.211	823098.505	136085.755
2040	413896.874	316030.314	841375.456	139889.047
2041	421916.693	322894.341	858948.745	144016.673
2042	429936.512	329758.368	876522.034	148144.299
2043	437956.331	336622.395	894095.323	152271.926
2044	445976.150	343486.421	911668.612	156399.552
2045	453995.969	350350.448	929241.901	160527.178
2046	462537.979	357669.454	948617.279	164934.047
2047	471079.989	364988.461	967992.657	169340.916
2048	479621.999	372307.467	987368.035	173747.785
2049	488164.010	379626.473	1006743.413	178154.654
2050	496706.020	386945.480	1026118.791	182561.522

Table J-7: SC-HFC-236fa (2020$)

	Discount rate and statistic			
Year	2.5%	3%	3% 95th Percentile	5%

2020	971911.32	635691.68	1671593.41	182719.62
2021	990966.334	650225.941	1712939.154	189003.615
2022	1010021.351	664760.197	1754284.899	195287.611
2023	1029076.368	679294.453	1795630.645	201571.608
2024	1048131.384	693828.709	1836976.391	207855.604
2025	1067186.401	708362.965	1878322.137	214139.600
2026	1087374.004	723836.127	1920231.244	220906.135
2027	1107561.607	739309.289	1962140.352	227672.670
2028	1127749.210	754782.450	2004049.460	234439.205
2029	1147936.813	770255.612	2045958.567	241205.740
2030	1168124.416	785728.774	2087867.675	247972.275
2031	1189329.895	802305.367	2136403.703	255826.244
2032	1210535.374	818881.960	2184939.731	263680.213
2033	1231740.853	835458.553	2233475.759	271534.182
2034	1252946.332	852035.146	2282011.786	279388.152
2035	1274151.811	868611.739	2330547.814	287242.121
2036	1296438.782	886109.188	2381068.457	295594.550
2037	1318725.754	903606.638	2431589.100	303946.979
2038	1341012.726	921104.088	2482109.743	312299.409
2039	1363299.698	938601.538	2532630.386	320651.838
2040	1385586.670	956098.988	2583151.028	329004.267
2041	1408441.699	974359.583	2635485.726	338463.005
2042	1431296.727	992620.177	2687820.423	347921.743
2043	1454151.756	1010880.772	2740155.121	357380.481
2044	1477006.785	1029141.366	2792489.818	366839.219
2045	1499861.814	1047401.961	2844824.516	376297.957
2046	1523747.327	1066577.257	2898382.352	386286.778
2047	1547632.840	1085752.553	2951940.189	396275.599
2048	1571518.353	1104927.849	3005498.026	406264.421
2049	1595403.866	1124103.145	3059055.863	416253.242
2050	1619289.379	1143278.441	3112613.700	426242.064

Table J-8: SC-HFC-245fa (2020$)

	Discount rate and statistic			
Year	**2.5%**	**3%**	**3% 95th Percentile**	**5%**
2020	79920.92	61300.90	161390.69	28587.55
2021	82459.557	63446.648	167363.131	29847.970
2022	84998.191	65592.394	173335.569	31108.389
2023	87536.826	67738.140	179308.007	32368.807
2024	90075.460	69883.886	185280.445	33629.226
2025	92614.095	72029.632	191252.883	34889.645
2026	95356.029	74354.956	197500.284	36269.117
2027	98097.963	76680.280	203747.684	37648.589
2028	100839.897	79005.603	209995.085	39028.061
2029	103581.831	81330.927	216242.485	40407.533
2030	106323.765	83656.250	222489.886	41787.005
2031	109426.575	86333.922	230330.054	43460.060
2032	112529.385	89011.593	238170.222	45133.114
2033	115632.195	91689.265	246010.390	46806.169
2034	118735.005	94366.936	253850.558	48479.224
2035	121837.815	97044.608	261690.726	50152.278
2036	125196.978	99939.251	269867.222	51961.200
2037	128556.141	102833.894	278043.717	53770.121
2038	131915.305	105728.538	286220.213	55579.043
2039	135274.468	108623.181	294396.709	57387.965
2040	138633.631	111517.824	302573.204	59196.886
2041	141916.845	114417.253	310725.593	61151.160
2042	145200.059	117316.683	318877.982	63105.433
2043	148483.273	120216.112	327030.370	65059.707
2044	151766.487	123115.542	335182.759	67013.980
2045	155049.701	126014.971	343335.148	68968.254
2046	158589.120	129137.145	351770.865	71067.545
2047	162128.539	132259.319	360206.582	73166.836
2048	165667.957	135381.493	368642.300	75266.127
2049	169207.376	138503.667	377078.017	77365.418
2050	172746.795	141625.840	385513.735	79464.709

Table J-9: SC-HFC-43-10mee (2020$)

	Discount rate and statistic			
Year	2.5%	3%	3% 95th Percentile	5%
2020	132976.19	100136.12	262542.58	43232.49
2021	136842.827	103357.628	271504.098	45019.695
2022	140709.459	106579.132	280465.619	46806.902
2023	144576.092	109800.636	289427.140	48594.110
2024	148442.724	113022.139	298388.661	50381.318
2025	152309.357	116243.643	307350.182	52168.526
2026	156513.011	119747.938	317037.761	54124.231
2027	160716.666	123252.233	326725.339	56079.936
2028	164920.320	126756.528	336412.918	58035.642
2029	169123.975	130260.823	346100.496	59991.347
2030	173327.629	133765.118	355788.075	61947.052
2031	177841.943	137606.700	366655.119	64229.658
2032	182356.257	141448.282	377522.163	66512.263
2033	186870.571	145289.863	388389.206	68794.869
2034	191384.885	149131.445	399256.250	71077.474
2035	195899.199	152973.026	410123.294	73360.080
2036	200701.567	157076.690	421305.310	75819.959
2037	205503.935	161180.355	432487.326	78279.838
2038	210306.303	165284.019	443669.342	80739.717
2039	215108.671	169387.683	454851.358	83199.596
2040	219911.039	173491.347	466033.374	85659.475
2041	224514.092	177516.883	476545.962	88252.826
2042	229117.145	181542.419	487058.550	90846.177
2043	233720.198	185567.956	497571.138	93439.528
2044	238323.251	189593.492	508083.726	96032.878
2045	242926.304	193619.028	518596.314	98626.229
2046	247831.642	197913.424	529594.395	101398.496
2047	252736.980	202207.819	540592.477	104170.763
2048	257642.319	206502.215	551590.559	106943.030
2049	262547.657	210796.610	562588.641	109715.298
2050	267452.996	215091.006	573586.723	112487.565

Table J-10: SC-HFC-23 (2020$)

	Discount rate and statistic			
Year	**2.5%**	**3%**	**3% 95th Percentile**	**5%**
2020	1483435.899	965975.482	2566380.066	274829.362
2021	1512334.175	987952.030	2628461.987	284263.718
2022	1541232.452	1009928.578	2690543.907	293698.075
2023	1570130.728	1031905.126	2752625.827	303132.431
2024	1599029.004	1053881.674	2814707.747	312566.788
2025	1627927.280	1075858.222	2876789.667	322001.145
2026	1658460.740	1099209.337	2940999.970	332155.387
2027	1688994.199	1122560.453	3005210.272	342309.629
2028	1719527.659	1145911.568	3069420.575	352463.871
2029	1750061.118	1169262.683	3133630.877	362618.114
2030	1780594.578	1192613.798	3197841.180	372772.356
2031	1812698.086	1217652.379	3271609.673	384571.571
2032	1844801.595	1242690.960	3345378.166	396370.786
2033	1876905.104	1267729.541	3419146.660	408170.001
2034	1909008.612	1292768.122	3492915.153	419969.216
2035	1941112.121	1317806.703	3566683.647	431768.431
2036	1974899.788	1344277.188	3642377.730	444342.072
2037	2008687.454	1370747.673	3718071.814	456915.713
2038	2042475.121	1397218.159	3793765.897	469489.354
2039	2076262.788	1423688.644	3869459.981	482062.995
2040	2110050.455	1450159.130	3945154.065	494636.636
2041	2144715.499	1477788.348	4026205.523	508872.690
2042	2179380.542	1505417.566	4107256.982	523108.744
2043	2214045.586	1533046.785	4188308.441	537344.798
2044	2248710.630	1560676.003	4269359.899	551580.852
2045	2283375.674	1588305.221	4350411.358	565816.905
2046	2319595.263	1617298.516	4433292.967	580829.914
2047	2355814.853	1646291.811	4516174.575	595842.922
2048	2392034.442	1675285.106	4599056.184	610855.931
2049	2428254.032	1704278.401	4681937.793	625868.939
2050	2464473.621	1733271.696	4764819.401	640881.948

Appendix K.Marginal Abatement Cost Curve MACC Analysis of Provisions Contained in the Proposed Rule

Introduction to Supplementary MACC Analysis

Background

This appendix applies an assessment of the costs and benefits of a subset of provisions contained in the proposed rule using an alternative methodology. This appendix has been prepared as a supplement to principal costs benefits detailed earlier in this draft RIA Addendum, and utilizes a Marginal Abatement Cost Curve (MACC) methodology that has been used for previous analyses for the estimation of costs and benefits for final rules issued separately under the AIM Act, *Phasedown of Hydrofluorocarbons: Establishing the Allowance Allocation and Trading Program Under the American Innovation and Manufacturing Act* (Allocation Framework Rule, 86 FR 55116, October 5, 2021), and *Phasedown of Hydrofluorocarbons: Allowance Allocation Methodology for 2024 and Later Years* (88 FR 46836, July 20, 2023) (referred to in this appendix as the Allocation Rule and 2024 Allocation Rule, respectively, or collectively as the “Allocation Rules"). Employing this methodology allows for comparability with EPA’s prior estimates of the costs and benefits of the HFC phasedown.

Differences in the estimated costs and benefits of specific provisions detailed in the above sections of this draft RIA Addendum compared to those presented in this appendix are related to methodological differences described in more detail in the sections below. At this time, EPA is presenting the results contained in this appendix as a supplementary analysis, and may revisit the assumptions used to develop the estimates presented in this appendix at a later date. Furthermore, while the analysis detailed below is currently considered to be supplementary, EPA may—upon review of public comments, available information, and technical expertise —use some or all of the methods described in this analysis for its principal costs/benefits estimates for the final subsection (h) rule.

Relationship to Allocation Framework Rule and 2024 Allocation Rule RIA Results

As discussed in section 3 of this draft RIA Addendum, EPA has previously estimated costs and benefits of the HFC phasedown, which are detailed in the Allocation Framework RIA and 2024 Allocation Rule RIA Addendum. In order to avoid double counting or overestimating of costs and benefits of the proposed action, for the purposes of this supplementary analysis the Allocation Rules are assumed to be the status quo from which incremental benefits may be calculated.

As with the estimates detailed earlier in this draft RIA Addendum, this supplementary analysis finds that requirements contained in the proposed rule may drive additional HFC consumption and emissions reductions beyond those previously assumed by EPA in its evaluation of the Allocation Rules. However—given that compliance with the HFC phasedown is met via a tradeable allowance system—these additional reductions may be offset by the "freeing up" of allowances for other subsectors. Ultimately, the extent of these potential offsetting effects is uncertain. Given this, and consistent with the approach taken elsewhere in this draft RIA Addendum, this supplementary analysis provides two scenarios to illustrate the range of potential incremental environmental impacts: a "base case" and a "high additionality case." In the base case scenario it is assumed that additional consumption reductions from this rule's requirements will be offset by the use of consumption allowances to meet demand in other subsectors. By contrast, in the "high additionality" it is assumed that additional consumption reductions resulting from this rule's provisions are fully additional to EPA's previous estimates in the Allocation Rule Reference Case (i.e., previously assumed consumption reduction options do not "backslide" or decrease in response to this rule).

Compliance Costs Evaluated

As detailed further in this appendix, EPA developed an updated MACC methodology to evaluate the following provisions contained in the proposed subsection (h) Rule:

- Leak inspection and leak repair requirements
- Use of automatic leak detection systems for CR and IPR appliances containing 1,500 pounds or more of refrigerant
- Use of reclaimed refrigerant for new equipment and/or servicing of specific RACHP appliances
- Requirements for the servicing, repair, disposal, or installation of fire suppression equipment

This analysis only evaluates costs (and benefits) associated with proposed Rule provisions that have been evaluated using EPA's Vintaging Model and MACC methodology. Provisions contained in the proposed Rule not evaluated using these methods include:

- Recordkeeping and reporting requirements
- Requirements pertaining to the management and tracking of cylinders of refrigerants and fire suppressants
- Alternative Resource Conservation and Recovery Act (RCRA) standards for spent ignitable refrigerants being recycled for reuse

Estimates of the costs and benefits of these provisions may be found in section 4 of this draft RIA Addendum.

Climate Benefits Evaluated

As with other analyses conducted by EPA for final and proposed AIM Act regulations, environmental benefits evaluated in this supplementary analysis derive from preventing the emissions of HFCs with high GWPs, thus reducing the damage from climate change that would have been induced by those emissions. Additional details on the climate impacts of HFCs and EPA's methodology for estimating the monetized benefits of reducing HFC emissions can be found in section 4.5 of this draft RIA Addendum and chapter 4 of the Allocation Rule RIA.

Factors Analyzed

This supplementary analysis takes into consideration the costs to meet proposed requirements and the environmental impacts of the consequent reduction in HFC consumption and emissions. As explained in the Allocation Framework RIA, specific factors evaluated in this assessment include capital costs, operations and maintenance (O&M) costs, and savings from avoiding refrigerant loss.

In addition, through the use of EPA's Vintaging Model and MACC methodology, this analysis takes into account multiple factors which are not incorporated into the principal costs and benefits estimates provided earlier in this draft RIA Addendum. These include: a) cost savings from an updated compliance pathway to meeting the HFC phasedown (relative to the Allocation Rule Reference case pathway); and b) additional emissions reductions from enhanced HFC recovery. These methodological differences and details on factors considered in this analysis are discussed in more detail in chapters 4, 5, and 6 of this document.

Compliance Costs

Modeling Method for Costs

To generate cost estimates for compliance with the proposed rule's provisions, EPA relied on a methodology consistent with the approach used in the Allocation Framework RIA (see Section 3.2 of the Allocation Framework RIA). As before, abatement options were used to estimate the consumption and emission reductions, the costs, and the societal benefits associated with compliance. Additional abatement options were evaluated and developed in order to model specific industry requirements contained in the proposed rule.

Abatement Options Modeled

Requirements contained in the proposed rule pertaining to leak repair, ALD, fire suppression, and reclamation were modeled as abatement options on a dollars-per-ton of avoided consumption basis. As discussed in the Allocation Rule RIA, abatement options can stem from a variety of compliance strategies, including reducing the amount of HFCs used in a piece of equipment (e.g., lowering charge sizes), and transitioning from using HFCs to alternatives such as hydrocarbons, ammonia, and hydrofluoroolefins (HFOs) or HFO blends. To model the specific requirements of the proposed rule, EPA evaluated abatement options falling into the following two general categories:

- reduce the amount needed for service (e.g., repair leaks)
- recover and reuse HFCs when equipment is decommissioned and disposed.

Error! Reference source not found. below provides a summary of abatement strategies modeled to evaluate the impact of the specific subsection (h) rule requirements. For each abatement option modeled, total net costs associated with the strategy (e.g., leak detection costs minus any anticipated savings) are divided by the total amount of avoided HFC consumption to derive a cost estimate on a dollars-per-ton basis. Based on this approach, the average dollar-per-ton "break even" cost tends to be higher for larger appliances or subsectors with large charge sizes, as opposed to smaller pieces of equipment where the amount of tons avoided is far lower. For example, leak repair of large IPR systems has an estimated abatement cost of approximately $1 per ton, whereas leak repair of medium IPR systems has an estimated abatement cost of approximately $37 per ton. Annexes A and B contain additional details on all abatement options develop and modeled for the proposed rule as well as their assumed break-even abatement costs in dollars per ton.

Table K-1: Summary of abatement strategies modeled and key factors evaluated to derive MAC estimates

Type of abatement strategy modeled	Corresponding requirements in proposed rule	Key Factors Evaluated to develop MAC abatement option
Reduction in amount of HFCs emissions	• Leak detection and repair for equipment containing 15 lbs or more of refrigerant • Use of ALD systems for CR and IPR appliances containing 1,500 pounds or more of HFC or substitutes • Venting prohibition for fire suppression equipment	**Abatement:** avoided HFC consumption required for to meet servicing demand **Costs:** conducting leak detection/ inspections and repairs; capital and O&M costs for ALD hardware **Savings:** refrigerant savings associated with detecting and repairing leaks earlier and avoiding emissions
Recovery and re-use of HFCs	• Use of reclaimed refrigerant for new equipment for specific RACHP appliance categories • Use of reclaimed refrigerant for servicing existing equipment for specific RACHP appliance categories • Use of recovered refrigerant for initial charge of fire suppression equipment • Use of recovered refrigerant for re-charging fire suppression equipment	**Abatement:** avoided virgin HFC consumption required to meet demand for initial charge or servicing **Costs:** cost of reclaimed HFCs **Savings:** avoided purchase of virgin HFCs

Costs from MACC Approach

The leak repair, automatic leak detection, fire suppression, and use of reclaim provisions modeled as MACC options each have a net cost or savings estimated per ton of CO_2 equivalent consumption or emissions abated. To evaluate the incremental cost of these provisions relative to EPA's previous analysis conducted for the Allocation Rules, these options were compared with the MACC options previously assumed to achieve compliance with the HFC phasedown. Given that the additional abatement options specific to the proposed subsection (h) rule would contribute to consumption reductions necessary to achieve the HFC phasedown, an updated MACC compliance path was generated which combines the (h) rule options with the prior Allocation Rule options.

Figures K**Error! Reference source not found.** and K**Error! Reference source not found.** below show the updated cost curves relative to those from the prior analysis. In our base case scenario, we assume all abatement options necessary to achieve the subsection (h) provisions occur, together with sufficient abatement options from the Allocation Rule analysis to meet the statutory phasedown caps in each year. A least-cost pathway is assumed in the base case scenario, whereby—after including the updated subsection (h) requirements—the most expensive remaining abatement options that are not required to achieve compliance are excluded. Since some of the updated abatement options specific to the subsection (h) rule are more cost effective than previous abatement options included in the Allocation Rules analyses, the resulting incremental impact of the rule is a net savings.

Figure K-1: 2024 Allocation Rule Cost Curve and Updated Cost Curve Including Subsection (h) Provisions in 2030

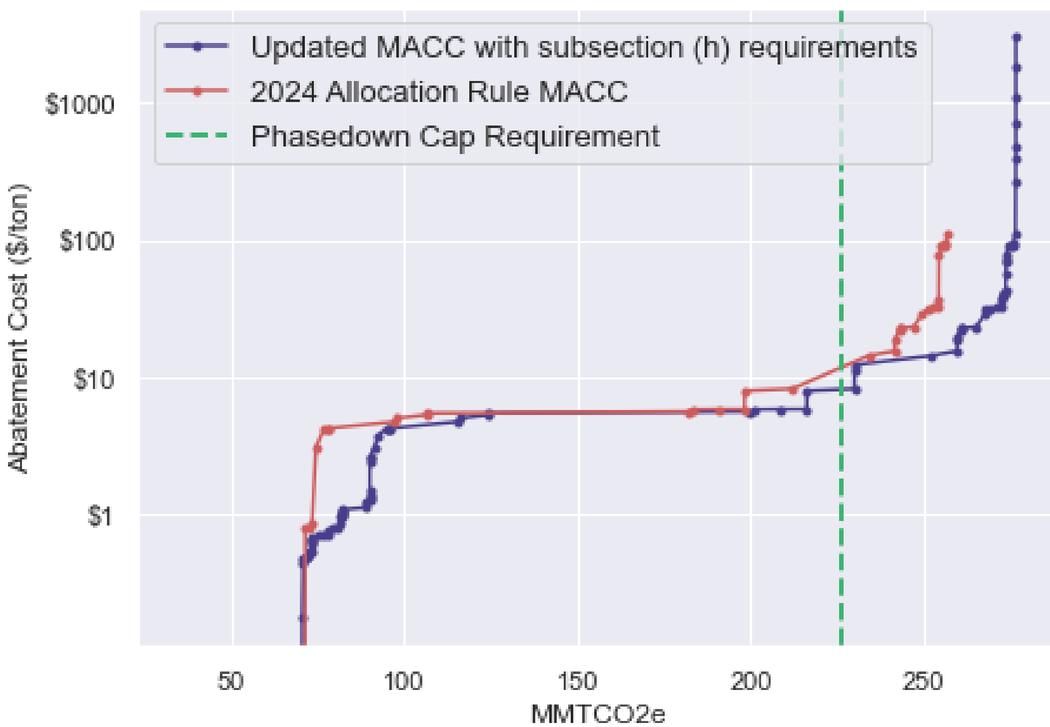
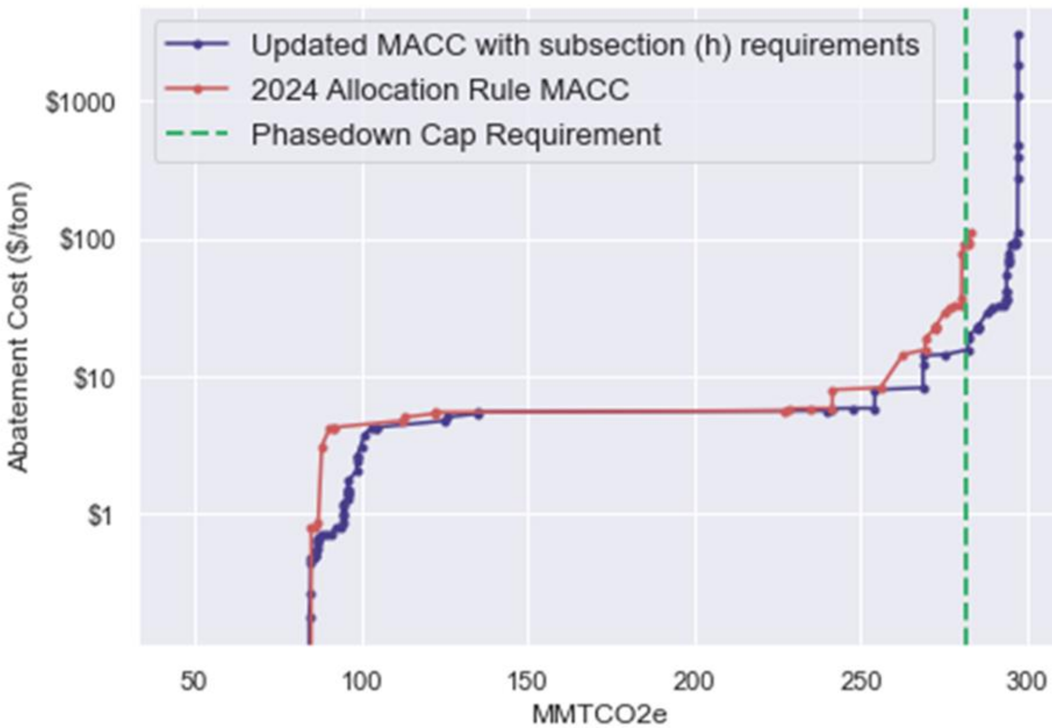


Figure K-2: 2024 Allocation Rule Cost Curve and Updated Cost Curve Including Subsection (h) Provisions in 2036 – Base Case Scenario



Using the MACC approach, the total compliance cost in each year for the modeled provisions is the sum of the product of abatement and cost ($/ton) for all the abatement options used in that year. The estimated annual compliance costs are presented in **Error! Reference source not found.** below.

Table K-2: Incremental Annual Compliance Costs of MAC Abatement Options (Billions 2022$)

Year	Total Incremental Compliance Costs Base Case	Total Incremental Compliance Costs High Additionality Case
2025	-$0.22	$0.27
2030	$0.07	$0.16
2035	$0.01	$0.15
2040	-$0.32	$0.14
2045	$0.23	$0.18
2050	$0.16	$0.22

Climate Benefits

As discussed in the above sections of this draft RIA Addendum, primary benefits of this proposed rule would derive from preventing the emissions of HFCs with higher GWPs, thus reducing the damage from climate change that would have been induced by those emissions. A more complete discussion of climate change damages and the social benefits of preventing them can be found in section 3.8 of this draft RIA Addendum as well as sections 4.1 and 4.2 of the Allocaton Framework Rule RIA.

While there may be other benefits to phasing down HFCs, the benefits monetized in this supplementary analysis are limited to the climate benefits of reduced HFC emissions.

Consumption and Emission Reductions

EPA's Vintaging Model is used to estimate both consumption and emissions for each regulated substance for each generation or "vintage" of equipment in the compliance scenarios evaluated for this analysis. Reductions in consumption (in units of MMTEVe) are calculated for a given year by summing the total tons avoided resulting from required abatement options in the compliance pathway. Emission reductions are similarly calculated by summing total emissions avoided across sectors/subsectors; however, these benefits typically lag corresponding reductions in consumption since they often occur over the course of equipment lifetime or during servicing and disposal.

Table K-3 below shows the consumption reductions by year corresponding to the subsection (h) Rule compliance scenarios (base case and high additionality case) evaluated in this supplementary analysis, which are compared to the Allocation Rule Reference Case to evaluate potential incremental reductions.

Table K-3: Annual Consumption Reductions in Allocation Rule Reference Case and Supplementary Subsection (h) Compliance Scenarios

	Allocation Rule Reference Case	Subsection (h) Base Case		Subsection (h) High Additionality Case	
Year	**Consumption Reduction (MMTEVe)**	**Consumption Reduction (MMTEVe)**	**Incremental Consumption Reduction (MMTEVe)**	**Consumption Reduction (MMTEVe)**	**Incremental Consumption Reduction (MMTEVe)**
2025	193	151	-42	200	7
2030	234	236	2	258	24
2035	270	276	6	285	15
2040	287	294	7	305	18
2045	285	307	22	307	21
2050	293	321	28	321	28
Total	**6,924**	**6,993**	**69**	**7,403**	**479**

Table K-4 below shows the emissions reductions by year corresponding to the Subsection (h) proposed Rule compliance scenarios (base case and high additionality case), which are compared to the Allocation Rule Reference Case to evaluate potential incremental reductions.

Table K-4: Annual Emissions Reductions in Allocation Rule Reference Case and Supplementary Subsection (h) Compliance Scenarios

	Allocation Rule Reference Case	Subsection (h) Base Case		Subsection (h) High Additionality Case	
Year	**Emissions Reduction (MMTEVe)**	**Emissions Reduction (MMTEVe)**	**Incremental Emissions Reduction (MMTEVe)**	**Emissions Reduction (MMTEVe)**	**Incremental Emissions Reduction (MMTEVe)**
2025	92.5	95.6	3.1	96.3	3.8
2030	108.0	128.8	20.9	132.6	24.6
2035	149.7	166.9	17.2	168.0	18.4
2040	197.0	198.3	1.4	200.0	3.1
2045	223.9	226.4	2.5	226.4	2.5
2050	239.1	241.1	1.9	241.1	1.9
Total	4,433	4,603	170	4,645	212

Monetized Climate Benefits Results

This analysis relies on the same methodology for calculating the social cost of HFC emissions as previous regulatory impact analyses conducted by EPA for AIM Act regulations[57] and detailed earlier in section 4.5 of this draft RIA Addendum.

To monetize the climate benefits resulting from the proposed subsection (h) rule provisions evaluated in this supplementary analysis, the HFC emission reductions in each year (Table K-4) are multiplied by the corresponding SC-HFC for that HFC in that year.

Table K-5 shows the undiscounted monetized incremental climate benefits from all regulated HFCs under the base case and high additionality case, evaluated from the Allocation Rule Reference Case. When the base case benefits are discounted to 2024 using a discount rate of 3 percent, the present value of the incremental benefits of the proposed subsection (h) rule provisions evaluated in this analysis for 2025–2050 are estimated to be $11.83 billion in 2020 dollars. This is equivalent to an annual incremental benefit of $0.68 billion per year over that timeframe. Similarly, the present value of the incremental benefits of the high additionality case from 2025–2050 are estimated to be $14.87 billion in 2020 dollars, discounting to 2022 using a discount rate of 3 percent, with an annual incremental benefit of $0.86 billion per year over that timeframe.

Table K-5: Discounted Monetized Climate Benefits 2025–2050 (billions of 2020$)[a,b,c]

Year	***Base Case Incremental Climate Benefits (billions 2020$)***	***High Additionality Case Incremental Climate Benefits (billions 2020$)***
2025	$0.2	$0.3
2026	$0.2	$0.3
2027	$0.1	$0.3
2028	$0.1	$0.3
2029	$1.9	$2.2
2030	$1.8	$2.2
2031	$1.8	$2.1
2032	$1.7	$2.1
2033	$1.6	$2.0
2034	$1.8	$1.9
2035	$1.7	$1.8
2036	$0.1	$0.4
2037	$0.1	$0.4
2038	$0.0	$0.4
2039	$0.0	$0.3
2040	$0.1	$0.3
2041	$0.3	$0.3

[57] Available at www.regulations.gov under Docket IDs EPA-HQ-OAR-2021-0044 and EPA-HQ-OAR-2022-0430.

2042	$0.3	$0.3
2043	$0.3	$0.3
2044	$0.3	$0.3
2045	$0.3	$0.3
2046	$0.3	$0.3
2047	$0.3	$0.3
2048	$0.3	$0.3
2049	$0.3	$0.3
2050	$0.3	$0.3
PV (3% d.r.)	**$11.83**	**$14.87**
EAV (3% d.r.)	**$0.68**	**$0.86**

[a] Rows may not appear to add correctly due to rounding.

[b] The equivalent annual values of benefits are calculated over a 26-year period from 2025 to 2050.

[c] Climate benefits are based on changes in HFC emissions and are calculated using four different estimates of the SC-HFCs (model average at 2.5 percent, 3 percent, and 5 percent discount rates; 95th percentile at 3 percent discount rate). For purposes of this table, we show effects associated with the model average at a 3 percent discount rate, but the Agency does not have a single central SC-HFC point estimate. We emphasize the importance and value of considering the benefits calculated using all four SC-HFC estimates. A consideration of climate effects calculated using discount rates below 3 percent, including 2 percent and lower, is also warranted when discounting intergenerational impacts.

Comparison of Benefits and Costs

Net Incremental Costs

This section summarizes the total incremental compliance costs (or savings) and the monetized incremental environmental benefits detailed in the sections above to provide an assessment of the total net incremental costs/benefits of requirements contained in the proposed rule that are evaluated in this supplementary analysis. As described above, abatement costs for the proposed subsection (h) provisions evaluated in this supplementary analysis were estimated using EPA's Vintaging Model and MACC methodology, while monetized climate benefits were estimated based on EPA's SC-HFC methodology.

Table K-6 below provides annual incremental costs, benefits, and net incremental costs of the subsection (h) rule provisions evaluated in this analysis, relative to the Allocation Rule Reference case. As shown, the present value net incremental benefits are estimated to range from $13.5 billion in the Base Case to $12.2 billion in the High Additionality Case, using a 3% discount rate. Present value estimates below are provided using a 3% discount rate for climate benefits and both a 3% and 7% discount rate for compliance costs.

Table K-6: Summary of Annual Incremental Climate Benefits, Costs, and Net Benefits in Base Case and High Additionality Case Scenarios for the 2025–2050 Timeframe (millions of 2020$, discounted to 2022)[a,b,c,d]

	Base Case			***High Additionality Case***		
Year	***Incre-mental Climate Benefits (3%)***	***Annual Costs (savings)***	***Net Benefits (3% Benefits, 3% or 7% Costs)*** [e]	***Incre-mental Climate Benefits (3%)***	***Annual Costs (savings)***	***Net Benefits (3% Benefits, 3% or 7% Costs)*** [e]
2025	$0.24	-$0.22	$0.02	$0.29	$0.27	$0.57
2026	$0.18	-$0.31	-$0.13	$0.30	$0.21	$0.51
2027	$0.11	-$0.35	-$0.24	$0.31	$0.21	$0.52
2028	$0.05	-$0.53	-$0.47	$0.34	$0.13	$0.47
2029	$1.94	$0.05	$2.00	$2.20	$0.23	$2.44
2030	$1.83	$0.07	$1.90	$2.17	$0.22	$2.40
2031	$1.78	$0.05	$1.84	$2.15	$0.21	$2.36
2032	$1.69	$0.04	$1.74	$2.08	$0.20	$2.29
2033	$1.60	$0.03	$1.63	$2.01	$0.19	$2.20
2034	$1.83	$0.02	$1.85	$1.93	$0.19	$2.11
2035	$1.70	$0.01	$1.71	$1.81	$0.18	$1.99
2036	$0.11	-$0.37	-$0.26	$0.37	$0.13	$0.50
2037	$0.08	-$0.38	-$0.30	$0.36	$0.13	$0.50

2038	$0.04	-$0.38		-$0.34		$0.36	$0.14		$0.49	
2039	$0.01	-$0.39		-$0.38		$0.35	$0.14		$0.49	
2040	$0.14	-$0.32		-$0.18		$0.34	$0.14		$0.48	
2041	$0.30	$0.00		$0.30		$0.33	$0.14		$0.47	
2042	$0.31	$0.14		$0.45		$0.31	$0.14		$0.45	
2043	$0.30	$0.14		$0.44		$0.30	$0.14		$0.44	
2044	$0.32	$0.22		$0.54		$0.32	$0.14		$0.46	
2045	$0.30	$0.23		$0.53		$0.30	$0.15		$0.45	
2046	$0.30	$0.23		$0.53		$0.30	$0.15		$0.45	
2047	$0.30	$0.23		$0.53		$0.30	$0.15		$0.44	
2048	$0.30	$0.23		$0.53		$0.30	$0.15		$0.45	
2049	$0.26	$0.15		$0.41		$0.26	$0.15		$0.41	
2050	$0.27	$0.16		$0.42		$0.27	$0.16		$0.42	
Discount rate	**3%**	**3%**	**7%**	**3%**	**7%**	**3%**	**3%**	**7%**	**3%**	**7%**
PV	**$11.83**	**-$1.34**	**-$1.23**	**$13.17**	**$13.06**	**$14.87**	**$3.05**	**$2.03**	**$11.82**	**$12.84**
EAV	**$0.68**	**-$0.08**	**-$0.11**	**$0.76**	**$0.79**	**$0.86**	**$0.18**	**$0.18**	**$0.68**	**$1.16**

[a] Benefits include only those related to climate. Climate benefits are based on changes in HFC emissions and are calculated using four different estimates of the SC-HFCs (model average at 2.5 percent, 3 percent, and 5 percent discount rates; 95th percentile at 3 percent discount rate). For purposes of this table, we show the effects associated with the model average at a 3 percent discount rate, but the Agency does not have a single central SC-HFC point estimate. We emphasize the importance and value of considering the benefits calculated using all four SC-HFC estimates. A consideration of climate effects calculated using discount rates below 3 percent, including 2 percent and lower, is also warranted when discounting intergenerational impacts.
[b] Rows may not appear to add correctly due to rounding.
[c] The annualized present value of costs and benefits are calculated as if they occur over a 26-year period from 2025 to 2050.
[d] The costs presented in this table are annual estimates.
[e] The PV for the 7% net benefits column is found by taking the difference between the PV of climate benefits at 3% and the PV of costs discounted at 7%. Due to the intergenerational nature of climate impacts the social rate of return to capital, estimated to be 7% in OMB's Circular A-4, is not appropriate for use in calculating PV of climate benefits.

Comparison to Subsection (h) Rule RIA Addendum Results

The analyses conducted for the subsection (h) proposed Rule are highly dependent on the assumptions made to model the proposed restrictions as well as the factors evaluated. The same is true for the Allocation Rule Reference Case and indeed all models. For this reason, we have presented sensitivity analyses and, in this case, an alternate methodology to explore how the potential results may change. For instance, in the Allocation Rule Reference Case, we explored how the costs or savings might change if the estimated abatement cost ($/ton CO_2e) were either higher or lower. We also explored the effect of alternate BAUs in the Allocation Rule RIA. In this draft RIA Addendum for the subsection (h) proposed

Rule, we looked at the compliance costs under different charge size threshold for which leak inspection and leak repair would be required, as well as the charge size and type of appliances for which ALDs would need to be installed. Results of these sensitivities may be found in the Allocation Rule RIA and in Appendix F of this draft RIA Addendum for the proposed subsection (h) Rule.

The alternate methodology presented in this supplementary analysis relies on a MACC analysis that builds on the methodology used for the Allocation Rule Reference Case. This approach yields different results and finds significantly higher incremental benefits than those estimated in the draft RIA Addendum, which relies on statistical assumptions of various factors (e.g., charge size per equipment type, leak rates before and after a leak event). As seen in the tables presented earlier in this document, over the 26-year time frame analyzed, the cumulative differences can be quite large. Following we describe key differences in the analytical approaches that lead to significant differences.

Assumptions regarding the amortization of ALD Costs

The rule proposes that certain IPR and CC equipment install an ALD system as a way to alert the owner or operator that a refrigerant-containing equipment is leaking. The effect is that the system would be repaired sooner than if no ALD was installed.

For the costs and benefits estimates detailed in sections 3 and 4 of this draft RIA Addendum, it is assumed that businesses treat ALD equipment as capital assets and therefore assumed that they would be able to access financing for the purchase of a direct ALD, if desired, for a loan tenure of five years. At an assumed cost of capital of 9.8%, this led to an annualized equipment and installation cost in the first five years of approximately $2,594 to $2,875. The annual Operations and Maintenance (O&M) costs for these systems were $1,250 and $1,440, respectively. In contrast, the capital cost and installation of an indirect ALD systems was not assumed to be financed and therefore was evaluated as a single capital cost of $2,650 to $2,850, depending on the size of equipment monitored, in the first year only. Annual O&M costs were estimated at $1,000 or $950, respectively.

In the MACC analysis contained in this appendix, the costs of the direct ALDs is handled differently. As referenced the Allocation Framework RIA, the development of an abatement cost ($/ton CO_2e) is simplified by assuming a single capital cost, a reoccurring annual cost, and a reoccurring annual revenue. Therefore, to develop the abatement cost for a direct ALD, the cost of purchasing and installing the equipment was spread over the full lifetime of the equipment. Because of the time value of money, the resulting costs estimated for the MACC analysis in this TSD for ALD system installation is significantly lower than the costs analyzed in the draft RIA Addendum.

Assumptions regarding enhanced recovery of HFCs from equipment

The Allocation Reference Case was developed to achieve each step-down in HFC consumption using a set of abatement options assumed to be available and technologically achievable during the compliance period.[58] Within this original set of abatement options, only the lowest-cost options needed to meet the consumption cap were assumed to be undertaken during a given time frame.[59] Given the level of each step-down in consumption, compared to the consumption reductions that could be achieved during the step-down, certain options could be needed during some years but not in other years.

One such option included in the Allocation Reference Case is pertains to the enhanced recovery of HFCs from equipment for use as reclaimed material. EPA's MACC methodology assumes that this option—if undertaken—results in both consumption reductions (given the use of reclaimed HFCs as opposed to virgin HFCs) as well as emissions reductions (since it is assumed that—if not recovered—the material would be released into the atmosphere). In the Allocation Rule Reference case, enhanced recovery was not assumed to be undertaken by industry in certain model years where more cost-effective options were available to meet the consumption reductions required by the phasedown steps.

In contrast, for the updated abatement pathway evaluated in this supplementary analysis it is assumed that a) the original enhanced recovery abatement option from the Allocation Reference Case occurs in all model years, and b) this recovery is further enhanced by an additional 1% beyond the BAU rate of recovery (which is modeled as an additional abatement option as discussed earlier in this appendix). These updated assumptions are incorporated in order to satisfy the use of reclaim requirements contained in the proposed rule and translate into significant avoided cumulative HFC emissions not included in the Allocation Rule Reference case, totaling approximately 128 MMT CO2e over the 2025–2050 modeling period. In contrast, for the principal costs and benefits estimates detailed in the above sections of this draft RIA Addendum, these incremental avoided HFC emissions due to enhanced HFC recovery are not fully evaluated, resulting in a significantly lower estimate of avoided HFC emissions.

Assumptions regarding compliance cost savings from alternate abatement pathway

As described earlier in this appendix, this supplementary analysis provides an updated MACC compliance pathway to meeting the HFC phasedown, based on the incorporation of additional measures to meet the

[58] More details on the set of abatement options modeled in the Allocation Rule Reference case can be found in section 3.2.2 of the Allocation Rule RIA.

[59] As discussed in section 3 of this analysis, EPA has conducted additional research and review to update the original set of abatement options included in the Allocation Rule Reference Case to include additional measures that meet provisions contained in the proposed subsection (h) rule. In some cases, these additional measures are more cost-effective than prior options included in the Reference Case, resulting in a more cost-effective compliance pathway to meeting the HFC phasedown.

leak repair, ALD, use of reclaim, and fire suppression-related provisions from the proposed rule. These additional measures are converted to abatement options on a dollars-per-ton-of-avoided HFC consumption basis, and in some cases represent more cost-effective means of meeting the HFC phasedown than measures originally included in the Allocation Rule Reference case. In the base case scenario included in this supplementary analysis, this updated pathway results in a net cost savings relative to the reference case, to the extent that more expensive abatement options are replaced by more cost-effective options required by the proposed rule.

The resulting savings over the 2025–2050 modeling period amount to a present value of approximately $1.4 billion, using a 3 percent discount rate. Since the principal costs and benefits estimated earlier in this draft RIA Addendum do not utilize a comparable MACC methodology, these incremental compliance savings were not evaluated and therefore excluded from the estimated incremental benefits.

Detailed Description of Mitigation Technologies Modeled Specific to the Subsection (h) Proposed Rule

For this supplementary analysis, updated abatement options were calculated for leak repair, ALD, use of reclaim, and fire suppression-related provisions contained in the proposed rule for each year of the analysis period (2025–2050). For calculating break-even costs, abatement potential was be calculated on a consumption basis, to be comparable to the abatement options presented in the Allocation Rules RIA analyses.

Leak repair of appliances

Abatement options for leak repair were calculated for the equipment types and sizes analyzed in the proposed rule draft RIA Addendum, using the same approach for estimating costs and benefits. In these options, it was assumed that emission benefits are equivalent to consumption benefits (i.e., that all avoided refrigerant emissions associated with repairing leaks translate into avoided virgin manufacture).

Table K-7: Leak Repair abatement options added to MACC model for the subsection (h) Rule analysis

Abatement Option No.	Type	Equipment Type	Equipment Size
1	Leak repair	School & Tour Bus AC	Sub-small
2	Leak repair	Transit Bus AC	Sub-small
3	Leak repair	Passenger Train AC	Sub-small
4	Leak repair	Chiller	Medium
5	Leak repair		Large
6	Leak repair	Modern Rail Transport	Sub-small
7	Leak repair	Vintage Rail Transport	Sub-small
8	Leak repair	Condensing Unit	Sub-small
9	Leak repair	Marine Transport	Small
10	Leak repair		Medium
11	Leak repair		Large
12	Leak repair	Rack	Medium

13	Leak repair		Large
14	Leak repair	Cold Storage	Large
15	Leak repair	IPR	Medium
16	Leak repair		Large

Automatic leak detection systems

Abatement options for requiring ALD systems in existing and new systems were calculated for the equipment types and sizes shown in table A-2. The approach for estimating capital, installation, and O&M costs of ALD systems was based on the assumptions used in the draft RIA Addendum for the proposed rule. The leak repair and inspection costs, refrigerant savings, and benefits of the ALD options were associated with repairs being conducted four weeks earlier (i.e., the incremental difference between the assumed six weeks earlier that repairs will be conducted without ALD and the 10 weeks earlier assumed for systems using ALD monitoring, as detailed in the draft RIA Addendum) and/or systems requiring fewer leak inspections (e.g., CR and IPR systems containing more than 1,500 pounds of refrigerant will switch from quarterly to annual inspections).

As with the added leak repair abatement options, it was assumed that emission benefits are equivalent to consumption benefits (i.e., that all avoided refrigerant emissions associated with repairing leaks translate into avoided virgin manufacture).

Table K-8: ALD abatement options added to MACC model for the subsection (h) Rule analysis

Option No.	Type	Equipment Type	Equipment Size
17	ALD	Marine Transport	Medium
18	ALD		Large
19	ALD	Rack	Medium
20	ALD		Large
21	ALD	Cold Storage	Large

Option No.	Type	Equipment Type	Equipment Size
22	ALD	IPR	Large

Use of reclaimed HFCs for initial charge of equipment starting January 1, 2028

In contrast with the leak repair and ALD options, abatement options for reclaim requirements was not derived from similar estimates contained in the draft RIA Addendum. These abatement options thus represent new costs and benefits not estimated elsewhere.

To quantify costs and benefits, a baseline for the use of reclamation in business-as-usual was first established. This baseline was derived from HFC reclamation totals modeled in the Vintaging Model[60] relative to modeled consumption for the ref/AC sector (i.e., new chemical demand and servicing demand) taking into account additional reclamation from the "disposal recovery" abatement option assumed in the Allocation Rule Reference Case. This prior activity assumed in the Allocation Rule Reference case was not included in the calculation of costs or benefits in order to avoid double counting with EPA's prior estimates. The assumed percentage of demand met by reclaimed refrigerant in the baseline per year is summarized in table A-3 below.

Table K-9: Baseline percentage of demand met by reclaim

Year	Baseline Percentage of Demand met by Reclaim
2028	47%
2029	49%
2030	53%
2031	56%
2032	59%
2033	62%
2034	62%

[60] The Vintaging Model assumes disposal recovery from equipment reaching end-of-life in a particular year is used to meet consumption demand for the same subsector and refrigerant (i.e., new chemical demand plus servicing demand) in the same year (i.e., reclamation). If disposal recovery is not sufficient to meet consumption demand, the remainder is assumed to be produced as virgin manufacture.

Year	Baseline Percentage of Demand met by Reclaim
2035	60%
2036	57%
2037	52%
2038	49%
2039	46%
2040	44%
2041	44%
2042	43%
2043	43%
2044	43%
2045	35%
2046	34%
2047	32%
2048	30%
2049	25%
2050	21%

The costs and/or cost savings estimated for this activity included the refrigerant price difference in reclaimed refrigerant vs. virgin refrigerant. For the purposes of this analysis, it was assumed that the price of reclaimed refrigerant is 10 percent higher than virgin manufacture, but additional sensitivity analysis can be conducted and EPA may revisit this assumption in future analyses.[61]

The consumption benefits of this proposed regulatory option needed to account for the proportion of virgin manufacture that the use of reclaimed refrigerant can offset. The maximum offset would be 85 percent, to account for the use of up to 15 percent virgin material in reclaimed refrigerant. However, a

[61] This baseline amount of reclaim is not accounted for in the costs/benefits of the leak repair options above (e.g., the average refrigerant price is assumed to represent the cost of virgin refrigerant).

reasonable assumption for an offset factor is expected to be lower than that maximum. Producers and importers are likely to increase their supply of reclaimed material—while producing/importing less virgin material—in response to end users' increasing demand for reclaimed rather than virgin material. Analysis suggested a reasonable offset factor of 50 to 65 percent. The use of an offset factor that is lower than 85% is a more conservative assessment of consumption benefits and assumes that the requirement to use reclaimed refrigerant will result in a smaller reduction in HFC consumption. For example, a 50 percent offset factor assumes that producers and importers produce/import 50 percent of the virgin refrigerant that they otherwise would have, in the absence of the requirement to use reclaimed material. For the purposes of this analysis, an offset factor of 65 percent was assumed. Additional sensitivity analysis can be conducted and EPA may revisit this assumption in future analyses.

Table K-10: Initial charge reclaim abatement options added to MACC model for the subsection (h) Rule analysis

Option No.	Type	Equipment Type
23	Initial charge – reclaim	Residential Unitary AC
24	Initial charge – reclaim	Small Commercial Unitary AC
25	Initial charge – reclaim	Large Commercial Unitary AC
26	Initial charge – reclaim	Window Units
27	Initial charge – reclaim	Packaged Terminal AC/Heat Pumps
28	Initial charge – reclaim	Ground-Source Heat Pumps
29	Initial charge – reclaim	Stand-Alone Retail Food Refrigeration
30	Initial charge – reclaim	Road Transport
31	Initial charge – reclaim	Intermodal Containers
32	Initial charge – reclaim	Automatic Commercial Ice Makers
33	Initial charge – reclaim	Modern Rail Transport
34	Initial charge – reclaim	Vintage Rail Transport
35	Initial charge – reclaim	Marine Transport
36	Initial charge – reclaim	Rack

37	Initial charge – reclaim	Cold Storage
38	Initial charge – reclaim	IPR

Use of reclaimed HFCs for servicing and/or repair of existing equipment starting January 1, 2028

This proposed requirement was modeled as a series of abatement options that account for whether the equipment types for which reclaimed refrigerant must be used are covered or not covered by the proposed leak repair requirements. For those equipment types covered by the proposed leak repair requirements, the abatement options further distinguish between: a) leak repair above the leak threshold; and b) additional servicing and/or repair that would be conducted that is below the leak rate threshold.

- *Leak repair above the leak threshold, using reclaimed refrigerant, for marine transport, modern rail transport, vintage rail transport, rack, cold storage, and IPR.*
    - To avoid double counting, these options supplant replace their equivalent, non-reclaim options listed above in Leak Repair and ALD (i.e., option numbers 6 – 22), starting in 2028. Costs and consumption benefits of leak repair using reclaimed refrigerant would be calculated using the leak repair methods described in the RIA Addendum—but substituting the price of reclaimed refrigerant and applying the "offset" percentage for reclaim described above.

Table K-11: Combined leak repair, ALD, and reclaim abatement options added to MACC model for the subsection (h) Rule analysis

Option No.	Type	Equipment Type	Equipment Size
39	Leak repair – reclaim	Modern Rail Transport	Sub-small
40	Leak repair – reclaim	Vintage Rail Transport	Sub-small
41	Leak repair – reclaim	Marine Transport	Small
42	Leak repair – reclaim		Medium
43	Leak repair – reclaim		Large
44	Leak repair – reclaim	Rack	Medium
45	Leak repair – reclaim		Large

46	Leak repair – reclaim	Cold Storage	Large
47	Leak repair – reclaim	IPR	Medium
48	Leak repair – reclaim		Large
49	ALD – reclaim	Marine Transport	Medium
50	ALD – reclaim		Large
51	ALD – reclaim	Rack	Medium
52	ALD – reclaim		Large
53	ALD – reclaim	Cold Storage	Large
54	ALD – reclaim	IPR	Large

- *Servicing and/or repair below the leak threshold using reclaimed refrigerant, for marine transport, modern rail transport, vintage rail transport, rack, cold storage, and IPR.*
  - For these abatement options, the amount of servicing was based on the difference between the amount of refrigerant replaced in each year (2028–2050) in equipment leaking above the leak threshold and the baseline amount of servicing demand modeled for these equipment types in the Vintaging Model. As for other reclaim options, the assumed costs reflect the price of reclaimed refrigerant and the benefits apply the offset percentage to translate from emissions to consumption.

Table K-12: Servicing reclaim abatement options added to MACC model for the subsection (h) Rule analysis

Option No.	Type	Equipment Type	Equipment Size
55	Servicing – reclaim	Modern Rail Transport	Sub-small
56	Servicing – reclaim	Vintage Rail Transport	Sub-small
57	Servicing – reclaim	Marine Transport	Small
58	Servicing – reclaim		Medium
59	Servicing – reclaim		Large
60	Servicing – reclaim	Rack	Medium

61	Servicing – reclaim		Large
62	Servicing – reclaim	Cold Storage	Large
63	Servicing – reclaim	IPR	Medium
64	Servicing – reclaim		Large

- *All servicing and/or repair for equipment types not covered by the proposed leak repair requirement.*
    - For these abatement options, servicing demand was derived from EPA's Vintaging Model. As with other reclaim options, the assumed costs reflect the price of reclaimed refrigerant and the benefits apply the offset percentage to translate from emissions to consumption.

Table K-13: Servicing reclaim abatement options added to MACC model for the subsection (h) Rule analysis, cont.

Option No.	Type	Equipment Type
65	Servicing other equipment types – reclaim	Residential Unitary AC
66	Servicing other equipment types – reclaim	Small Commercial Unitary AC
67	Servicing other equipment types – reclaim	Large Commercial Unitary AC
68	Servicing other equipment types – reclaim	Window Units
69	Servicing other equipment types – reclaim	Packaged Terminal AC/Heat Pumps
70	Servicing other equipment types – reclaim	Ground-Source Heat Pumps
71	Servicing other equipment types – reclaim	Stand-Alone Retail Food Refrigeration
72	Servicing other equipment types – reclaim	Road Transport
73	Servicing other equipment types – reclaim	Intermodal Containers
74	Servicing other equipment types – reclaim	Automatic Commercial Ice Makers

Fire suppression equipment

An additional set of abatement options was run for rule provisions associated with restricting intentional releases (e.g., during installation, servicing, repairing, or disposal) of fire suppression equipment. Abatement options for total flooding fire suppression systems were calculated assuming a proportion of the annual leakage amount (assumed to be 0.5 percent) for total flooding systems estimated in the Vintaging Model is avoided through the venting restriction. Cost savings are assumed because losses during testing of new or existing systems would have been replaced before the unit enters or reenters service.[62]

Because the venting restriction and reclamation requirement for servicing/repair of fire suppression equipment start in the same year (2025), the venting prohibition option assumes that intentional venting during testing would have been replaced with reclaimed agent, and therefore, as for other reclaim options, the assumed costs reflect the price of reclaimed refrigerant and the benefits apply the offset percentage to translate from emissions to consumption.

In addition, options associated with the requirement to use reclaim in servicing (i.e., for normal operating leaks and servicing) for total flooding systems and filling of new fire suppression systems for total flooding and streaming were considered. Costs and benefits for these options were calculated using the same approach as that used for refrigeration and AC equipment.

Table K-14: Fire suppression abatement options added to MACC model for the subsection (h) Rule analysis

Option No.	Type	Equipment Type
75	Venting prohibition – reclaim	Fire Extinguishing: Flooding Agents
76	Servicing– reclaim	Fire Extinguishing: Flooding Agents
77	Initial charge – reclaim	Fire Extinguishing: Streaming Agents
78	Initial charge – reclaim	Fire Extinguishing: Flooding Agents

[62] An abatement option for the venting prohibition requirement is only applied to total flooding systems because streaming systems are not assumed to be serviced and therefore have no consumption benefits associated with avoiding leaks (i.e., losses from intentional venting are not replaced over the lifetime of the equipment). The venting prohibition would have potential emission benefits for streaming systems. Similarly, an abatement option for the servicing reclaim requirement is only applied to total flooding systems because streaming systems are not assumed to be serviced.

Summary Table of Mitigation Options Modeled Specific to the Subsection (h) Rule

Table K-15: Summary of Mitigation Options Modeled

Option No.	Type	Equipment Type	Equipment Size	Breakeven Cost ($/ton MT CO2e)
1	Leak Repair	School & Tour Buses	Sub-small	$3,050.69
2	Leak Repair	Transit Buses	Sub-small	$1,800.98
3	Leak Repair	Trains	Sub-small	$470.91
4	Leak Repair	Chillers	Medium	$38.83
5	Leak Repair	Chillers	Large	$10.37
6	Leak Repair	Modern Rail Transport	Sub-small	$547.74
7	Leak Repair	Vintage Rail Transport	Sub-small	$358.57
8	Leak Repair	Condensing Units	Sub-small	$464.45
9	Leak Repair	Marine Transport	Small	$21.16
10	Leak Repair	Marine Transport	Medium	$21.01
11	Leak Repair	Marine Transport	Large	$10.19
12	Leak Repair	Rack	Medium	$33.20
13	Leak Repair	Rack	Large	$15.31
14	Leak Repair	Cold Storage	Large	0.61
15	Leak Repair	IPR	Medium	$36.56
16	Leak Repair	IPR	Large	$0.80
17	ALD	Marine Transport	Medium	$28.57
18	ALD	Marine Transport	Large	$19.44
19	ALD	Rack	Medium	$189.46
20	ALD	Rack	Large	$130.70
21	ALD	Cold Storage	Large	6.97
22	ALD	IPR	Large	$20.94

Option No.	Type	Equipment Type	Equipment Size	Breakeven Cost ($/ton MT CO2e)
23	Initial charge - reclaim	Residential Unitary AC		$3.78
24	Initial charge - reclaim	Small Commercial Unitary AC		$1.49
25	Initial charge - reclaim	Large Commercial Unitary AC		$1.77
26	Initial charge - reclaim	Window Units		$1.17
27	Initial charge - reclaim	Packaged Terminal AC/Heat Pumps		$1.41
28	Initial charge - reclaim	Ground-Source Heat Pumps		$1.23
29	Initial charge - reclaim	Stand-Alone Retail Food Refrigeration		$1.40
30	Initial charge - reclaim	Road Transport		$0.55
31	Initial charge - reclaim	Intermodal Containers		$1.02
32	Initial charge - reclaim	Automatic Commercial Ice Makers		$0.53
33	Initial charge - reclaim	Modern Rail Transport		$0.66
34	Initial charge - reclaim	Vintage Rail Transport		$-
35	Initial charge - reclaim	Marine Transport		$0.49
36	Initial charge - reclaim	Rack		$0.72
37	Initial charge - reclaim	Cold Storage		$-
38	Initial charge - reclaim	IPR		$-
39	Leak repair - reclaim	Modern Rail Transport	Sub-small	$1,094.88
40	Leak repair - reclaim	Vintage Rail Transport	Sub-small	$715.98
41	Leak repair - reclaim	Marine Transport	Small	$41.86
42	Leak repair - reclaim	Marine Transport	Medium	$41.56
43	Leak repair - reclaim	Marine Transport	Large	$19.81
44	Leak repair - reclaim	Rack	Medium	$65.81

Option No.	Type	Equipment Type	Equipment Size	Breakeven Cost ($/ton MT CO2e)
45	Leak repair - reclaim	Rack	Large	$30.04
46	Leak repair - reclaim	Cold Storage	Large	1.10
47	Leak repair - reclaim	IPR	Medium	$72.14
48	Leak repair - reclaim	IPR	Large	$1.02
49	ALD - reclaim	Marine Transport	Medium	$56.51
50	ALD - reclaim	Marine Transport	Large	$38.24
51	ALD - reclaim	Rack	Medium	$378.23
52	ALD - reclaim	Rack	Large	$260.72
53	ALD - reclaim	Cold Storage	Large	13.76
54	ALD - reclaim	IPR	Large	$41.25
55	Servicing - reclaim	Modern Rail Transport	Sub-small	$0.66
56	Servicing - reclaim	Vintage Rail Transport	Sub-small	$1.23
57	Servicing - reclaim	Marine Transport	Small	$0.48
58	Servicing - reclaim	Marine Transport	Medium	$0.49
59	Servicing - reclaim	Marine Transport	Large	$0.63
60	Servicing - reclaim	Rack	Medium	$0.68
61	Servicing - reclaim	Rack	Large	$0.68
62	Servicing - reclaim	Cold Storage	Large	$0.45
63	Servicing - reclaim	IPR	Medium	$-
64	Servicing - reclaim	IPR	Large	$0.68
65	Servicing other equipment types - reclaim	Residential Unitary AC	Sub-small	$1.01
66	Servicing other equipment types - reclaim	Small Commercial Unitary AC	Sub-small	$0.90
67	Servicing other equipment types - reclaim	Large Commercial Unitary AC	Sub-small	$0.94
68	Servicing other equipment types - reclaim	Window Units	Sub-small	$0.96

Option No.	Type	Equipment Type	Equipment Size	Breakeven Cost ($/ton MT CO2e)
69	Servicing other equipment types - reclaim	Packaged Terminal AC/Heat Pumps	Sub-small	$0.91
70	Servicing other equipment types - reclaim	Ground-Source Heat Pumps	Sub-small	$0.97
71	Servicing other equipment types - reclaim	Stand-Alone Retail Food Refrigeration	Sub-small	$1.26
72	Servicing other equipment types - reclaim	Road Transport	Sub-small	$0.50
73	Servicing other equipment types - reclaim	Intermodal Containers	Sub-small	$1.12
74	Servicing other equipment types - reclaim	Automatic Commercial Ice Makers	Sub-small	$0.53
75	Venting prohibition - reclaim	Fire Extinguishing: Flooding Agents (w/ Venting Prohibition)		$0.51
76	Servicing - reclaim	Fire Extinguishing: Flooding Agents		$0.51
77	Initial charge - reclaim	Fire Extinguishing: Streaming Agents		$0.18
78	Initial charge - reclaim	Fire Extinguishing: Flooding Agents		$0.50

Appendix L. Unfunded Mandates Reform Act Statement

Pursuant to the Title II of the Unfunded Mandates Reform Act (UMRA), 2 U.S.C. 1531-1538, EPA has determined that the proposed rule, "*Phasedown of Hydrofluorocarbons: Management of Certain Hydrofluorocarbons and Substitutes under Subsection (h) of the American Innovation and Manufacturing Act of 2020; Proposed Rule*," contains a federal mandate that may result in expenditures of $100 million or more by the private sector in any one year, but is not expected to result in expenditures of this magnitude by State, local, and Tribal governments in the aggregate. EPA has prepared this statement in accordance with section 202(a) of UMRA.

(1) Authorizing Legislation. This rule is issued under the authority of subsection (h) of the American Innovation and Manufacturing (AIM) Act, 42 U.S.C. § 7675(h).

(2) Benefit-Cost Analysis. EPA has prepared an economic analysis to evaluate, among other things, the benefits and costs of this rule. See "Draft Regulatory Impact Analysis Addendum: Analysis of the Economic Impact and Benefits of the Proposed Rule: American Innovation and Manufacturing (AIM) Act Subsection H Management of Regulated Substances" This document is available in the public docket for this rule.

In the Draft Regulatory Impact Analysis (RIA) Addendum, the total estimated compliance costs for the period 2025–2050 period are estimated in terms of their present value (PV) as well as their equivalent annualized value (EAV), which represents a flow of constant annual values that, had they occurred in each year, would yield a sum equivalent to PV. These estimates are provided using both 3 percent and 7 percent discount rates. The EAV of total compliance costs associated with the proposed rule is estimated to be approximately $213 million using a 3 percent discount rate and $217 million using a 7 percent discount rate.

When adjusted for inflation, the $100 million UMRA threshold established in 1995 is equivalent to approximately $184 million in 2022 dollars, the year dollars for the cost estimates in this proposed rule. Thus, the cost of the rule to the private sector exceeds the inflation-adjusted UMRA threshold in any one year.

Most of the estimated compliance costs would be incurred by owners and operators of refrigeration, air conditioning, and heat pumps (RACHP) equipment using HFC refrigerants. For informational purposes, EPA has also estimated environmental benefits from the proposed rule in terms of avoided climate damages. Using EPA's social cost of HFCs methodology described in the Draft RIA Addendum, the total value of these monetized benefits significantly outweighs the above-mentioned compliance costs. When accounting for these benefits, the EAV of total net benefits (benefits minus costs) stemming from the proposed ranges from approximately $353 million (when discounting compliance costs at 3 percent) to $349 million (when discounting compliance costs at 7 percent). Although EPA is using SC-HFCs for purposes of some of the analysis in the RIA addendum, this proposed action does not rely on those estimates of these costs as a record basis for the Agency action, and EPA would reach the proposed conclusions even in the absence of the social costs of HFCs.

> **(A) Federal Financial Assistance.** EPA has not identified any sources of federal financial assistance (e.g., grants or loans) that are available from either EPA or other federal agencies to defray State, local, or Tribal expenditures under this rule.

> **(B) Federal Resources.** EPA has not identified any federal resources available to carry out the private sector mandate contained in this rule.

(3) Costs and Budgetary Impacts.

> **(A) Future Compliance Costs.** Total estimated compliance costs of the proposed rule are estimated to be approximately $213 to $217 million per year for the period 2025–2050.

> **(B) Disproportionate Budgetary Effects.** EPA has no evidence to suggest that this rule will have disproportionate budgetary impacts on any particular industry or region of the country.

(4) Effect on National Economy. Given the current gross domestic product (GDP) for the United States, the cost of this proposed rule, as shown in the economic analysis, are around one thousandth of one percent of U.S. GDP. Therefore, EPA has concluded that this rule is highly unlikely to have a significant effect on the national economy.

(5) Prior consultation with affected State, local, and Tribal governments. This action contains no unfunded federal mandate for State, local, and Tribal governments as described in UMRA, 2 U.S.C. 1531–1538. While this rule contains a federal mandate that may result in expenditures that exceed the inflation-adjusted UMRA threshold of $100 million by the private sector in any one year, it is not expected to result in expenditures of this magnitude by State, local, and Tribal governments in the aggregate. Therefore, EPA did not consult with State, local, or Tribal governments, however State, local, or Tribal governments have participated in EPA-hosted stakeholder meetings.

(6) Small Government Agency Plan. This rule does not contain a significant federal intergovernmental mandate as described by § 203 of UMRA, because this action is not subject to the requirements of section 203 of UMRA because it contains no regulatory requirements that might significantly or uniquely affect small governments. Therefore, EPA did not prepare a small government agency plan.