UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

# Regulatory Impact Analysis for the Final National Emission Standards for Hazardous Air Pollutants: Gasoline Distribution Technology Review and Standards of Performance for Bulk Gasoline Terminals Review

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# Regulatory Impact Analysis for the Final National Emission Standards for Hazardous Air Pollutants: Gasoline Distribution Technology Review and Standards of Performance for Bulk Gasoline Terminals Review

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# 1 EXECUTIVE SUMMARY

## 1.1 Background

The U.S Environmental Protection Agency (EPA) is finalizing amendments to the National Emissions Standards for Hazardous Air Pollutants (NESHAP) for Gasoline Distribution Facilities (40 CFR part 60, subparts R and BBBBBB) and the Standards of Performance for Bulk Gasoline Terminals (40 CFR part 60, subparts XX and XXa). The EPA is finalizing revisions to NESHAP requirements for storage tanks, loading operations, and equipment leaks to reflect cost-effective developments in practices, processes, or controls of hazardous air pollutants (HAP). The EPA is also finalizing New Source Performance Standards (NSPS) to reflect best system of emissions reduction (BSER) for emissions of volatile organic compounds (VOC) from loading operations and equipment leaks at bulk gasoline terminals. This final action also includes revisions related to emissions during periods of startup, shutdown, and malfunction (SSM); additional requirements for electronic reporting of performance test results, performance evaluation reports, and compliance reports; revisions to monitoring and operating requirements for control devices; and other minor technical improvements. The final amendments would cumulatively reduce projected emissions of HAP from this source category by over 2,200 short tons (English tons) per year and would reduce emissions of VOC by 45,400 short tons per year. The great majority of these projected HAP and VOC emission reductions would occur as a result of the final area source NESHAP technology review.

In accordance with E.O. 12866 and 13563, the guidelines of OMB Circular A-4 and EPA’s *Guidelines for Preparing Economic Analyses* (U.S. EPA, 2016), the EPA prepared a Regulatory Impact Analysis (RIA) for the proposal of this action that analyzed the benefits and costs associated with the projected emissions reductions under the proposed requirements, a less stringent set of requirements, and a more stringent set of requirements. Prior to the amendments made by E.O. 14094, the proposal of this rule was significant under E.O. 12866 Section 3(f)(1) due to its likely annual effect on the economy of $100 million or more in any one year on the economy, a sector of the economy, productivity, competition, jobs, the environment, public health or safety, or state, local, or Tribal governments or communities. Specifically, monetized health benefits from projected VOC reductions associated with the proposed amendments to 40 CFR part 60 subpart BBBBBB exceeded $100 million per year. On April 6, 2023, President

Biden issued E.O. 14094: Modernizing Regulatory Review, which increased the threshold for significance under E.O. 12866 Section 3(f)(1) from $100 million to $200 million. This final action is significant under E.O. 12866 Section 3(f)(1) as amended by E.O. 14094. Accordingly, the EPA has prepared this Regulatory Impact Analysis (RIA).

### 1.1.1 *NESHAP 40 CFR Part 60, Subparts R and BBBBBB*

The statutory authority for the final NESHAP amendments is provided by sections 112 and 301 of the Clean Air Act (CAA), as amended (42 U.S.C. 7401 *et seq*.). Section 112 of the CAA establishes a two-stage regulatory process to develop standards for emissions of HAP from stationary sources. Generally, the first stage involves establishing technology-based standards and the second stage involves evaluating those standards that are based on maximum achievable control technology (MACT) to determine whether additional standards are needed to address any remaining risk associated with HAP emissions. This second stage is commonly referred to as the "residual risk review." In addition to the residual risk review, the CAA also requires the EPA to review standards set under CAA section 112 every 8 years and revise the standards as necessary taking into account any "developments in practices, processes, or control technologies." This review is commonly referred to as the "technology review," and is the subject of this action, which finalizes amendments proposed in June 2022.

In the first stage of the CAA section 112 standard setting process, the EPA promulgates technology-based standards under CAA section 112(d) for categories of sources identified as emitting one or more of the HAP listed in CAA section 112(b). Sources of HAP emissions are either major sources or area sources, and CAA section 112 establishes different requirements for major source standards and area source standards. "Major sources" are those that emit or have the potential to emit 10 tons per year (tpy) or more of a single HAP or 25 tpy or more of any combination of HAP. All other sources are "area sources." For major sources, CAA section 112(d)(2) provides that the technology-based NESHAP must reflect the maximum degree of emission reductions of HAP achievable (after considering cost, energy requirements, and non-air quality health and environmental impacts). These standards are commonly referred to as MACT standards. CAA section 112(d)(3) also establishes a minimum control level for MACT standards, known as the MACT "floor." In certain instances, as provided in CAA section 112(h), the EPA may set work practice standards in lieu of numerical emission standards. The EPA must also consider control options that are more stringent than the floor. Standards more stringent than the floor are commonly referred to as beyond-the-floor standards. For area sources, CAA section 112(d)(5) allows the EPA to set standards based on generally available control technologies or management practices (GACT standards) in lieu of MACT standards. For categories of major sources and any area source categories subject to MACT standards, the second stage in standard-setting focuses on identifying and addressing any remaining (*i.e.*, "residual") risk pursuant to CAA section 112(f) and concurrently conducting a technology review pursuant to CAA section 112(d)(6). MACT standards were finalized for the Gasoline Distribution source category in 1994. The residual risk and technology review was finalized in 2006. GACT standards were set for the Gasoline Distribution area source category in 2008.

The sources affected by the current area source NESHAP for the Gasoline Distribution source category subpart BBBBBB (GACT 6B) are bulk gasoline terminals, bulk gasoline plants, and pipeline facilities. A bulk gasoline terminal is defined as "any gasoline storage and distribution facility that receives gasoline by pipeline, ship or barge, or cargo tank and has a gasoline throughput of 20,000 gallons per day or greater." A bulk gasoline plant is defined as "any gasoline storage and distribution facility that receives gasoline by pipeline, ship or barge, or cargo tank, and subsequently loads the gasoline into gasoline cargo tanks for transport to gasoline dispensing facilities and has a gasoline throughput of less than 20,000 gallons per day." A pipeline breakout station is defined as "a facility along a pipeline containing storage vessels used to relieve surges or receive and store gasoline from the pipeline for re-injection and continued transportation by pipeline or to other facilities." A pipeline pumping station is defined as "a facility along a pipeline containing pumps to maintain the desired pressure and flow of product through the pipeline, and not containing gasoline storage tanks other than surge control tanks." Emissions from loading racks at large bulk gasoline terminals (those with gasoline throughput of 250,000 gallons per day or greater) are controlled by vapor collection and processing systems meeting 80 milligrams total organic carbon (TOC) per liter of gasoline loaded (mg/L) and the cargo tanks being loaded must be certified to be vapor tight. Small bulk gasoline terminals and bulk gasoline plants must use submerged filling when loading gasoline. Emissions from storage vessels with a design capacity greater than or equal to 75 cubic meters ($m^3$) are controlled by equipment designed to capture and control emissions. Equipment leaks are repaired upon detection using audio, visual, and olfactory (AVO) methods. More information on AVO detection methods can be found in the technical memo for equipment leak control options.[1]

The sources affected by the current major source NESHAP for the Gasoline Distribution source category subpart R (MACT R) are bulk gasoline terminals and pipeline breakout stations. A bulk gasoline terminal is defined as “any gasoline facility which receives gasoline by pipeline, ship, or barge, and has a gasoline throughput greater than 75,700 liters per day.”[2] A pipeline breakout station is defined as “a facility along a pipeline containing storage vessels used to relieve surges or receive and store gasoline from the pipeline for reinjection and continued transportation by pipeline or to other facilities.” Emissions from loading racks are controlled by vapor collection and processing systems meeting 10 mg/L and the cargo tanks being loaded must be certified to be vapor tight. Emissions from storage vessels with a design capacity greater than or equal to 75 $m^3$ are controlled by equipment designed to capture and control emissions. Equipment leaks are required to be repaired upon detection using AVO methods.

### 1.1.2 *NSPS 40 CFR part 60, Subpart XX and XXa*

The EPA’s authority for the NSPS is CAA section 111, which governs the establishment of standards of performance for stationary sources. CAA section 111(b)(1)(A) requires the EPA Administrator to list categories of stationary sources that in the Administrator’s judgement cause or contribute significantly to air pollution that may reasonably be anticipated to endanger public health or welfare. The EPA must then issue performance standards for new (and modified or reconstructed) sources in each source category pursuant to CAA section 111(b)(1)(B). These standards are referred to as new source performance standards, or NSPS. The EPA has the authority under CAA section 111(b) to define the scope of the source categories, determine the pollutants for which standards should be developed, set the emission level of the standards, and distinguish among classes, type, and sizes within categories in establishing the standards.

Section 111(b)(1)(B) of the CAA requires the EPA to “at least every 8 years review and, if appropriate, revise” new source performance standards. Section 111(a)(1) of the CAA provides

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[1] RTI, 2023. Delang, M., & Coburn, J. (2023). Memorandum to Brenda Shine, EPA/OAQPS. Updated Control Options for Equipment Leaks at Gasoline Distribution Facilities. EPA-HQ-OAR-2020-0371.

[2] 75,700 liters per day is approximately equal to 20,000 gallons per day.

that performance standards are to “reflect the degree of emission limitation achievable through the application of the best system of emission reduction which (taking into account the cost of achieving such reduction and any non-air quality health and environmental impact and energy requirements) the Administrator determines has been adequately demonstrated.” We refer to this level of control as the best system of emission reduction or “BSER.” The term “standard of performance” in CAA 111(a)(1) makes clear that the EPA is to determine both the BSER for the regulated sources in the source category and the degree of emission limitation achievable through application of the BSER. The EPA must then, under CAA section 111(b)(1)(B), promulgate standards of performance for new sources that reflect that level of stringency. The NSPS for Bulk Gasoline Terminals was promulgated in 1983.

The sources affected by the current NSPS for the Bulk Gasoline Terminals source category subpart XX are bulk gasoline terminals that commenced construction or modification after December 17, 1980. NSPS subpart XX defines bulk gasoline terminals as “any gasoline facility which receives gasoline by pipeline, ship or barge, and has a gasoline throughput greater than 75,700 liters per day.” Emissions from loading racks at bulk gasoline terminals are controlled by vapor collection and processing systems meeting 35 mg/L and the cargo tanks being loaded must be certified to be vapor tight.[3] Equipment leaks are required to be repaired upon detection using AVO methods. Emissions from storage vessels are regulated under a separate NSPS (40 CFR part 60, subpart K, Ka, or Kb). In June 2022, EPA proposed a new subpart at 40 CFR part 60: subpart XXa. The proposed standards reflect the best system of emission reduction (BSER) for loading operations and equipment leaks at bulk gasoline distribution facilities and apply to all such facilities that commence construction, modification, or reconstruction after June 10, 2022. In this action, EPA is finalizing this new subpart XXa.

## 1.2 Market Failure

Many regulations are promulgated to correct market failures, which otherwise lead to a sub-optimal allocation of resources within a market. Air quality and pollution control regulations address “negative externalities” whereby the market does not internalize the full opportunity cost of production borne by society as public goods such as air quality are unpriced.

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[3] Allowance is provided to meet 80 mg/L for affected facilities with an “existing vapor processing system.”

While recognizing that the socially optimal level of pollution may not be zero, HAP and VOC emissions impose costs on society, such as negative health and welfare impacts, that are not reflected in the market price of the goods produced through the polluting process. For this regulatory action the good produced is gasoline. If the process of transporting gasoline from refineries and distributing it to consumers pollutes the atmosphere, the social costs imposed by the pollution will not be borne by the polluting firm but rather by society as a whole. Thus, the producer is imposing a negative externality, or a social cost from these emissions, on society. The equilibrium market price of gasoline may fail to incorporate the full opportunity cost to society of consuming the gasoline. Consequently, absent a regulation or some other action to limit emissions, producers will not internalize the negative externality of pollution due to emissions and social costs will be higher as a result. This regulation will work towards addressing this market failure by causing affected producers to begin internalizing the negative externality associated with HAP and VOC emissions.

## 1.3 Results for the Final Action

### 1.3.1 *Baseline for the Regulation*

The impacts of regulatory actions are evaluated relative to a baseline that represents the world without the regulatory action, which is consistent with the definition stated in the EPA’s *Guidelines for Preparing Economic Analyses* (U.S. EPA, 2016). In this RIA, the EPA presents results for the final amendments to NESHAP GACT 6B and MACT R and final NSPS XXa. Throughout this document, the EPA focuses the analysis on the requirements that result in quantifiable compliance cost or emissions changes compared to the baseline. For each rule and most emissions sources, EPA assumed each facility achieved emissions control meeting current standards and estimated emissions and cost relative to this baseline. We calculate cost and emissions reductions relative to the baseline for the period 2027-2041. This time frame was selected because it spans the projected first full year of implementation of the final NESHAP amendments through the lifetime of the longest-lived capital equipment expected to be installed as a result of the amendments. NSPS XXa took effect upon proposal in June 2022. Given the relatively small impacts of NSPS XXa compared to those from the final NESHAP amendments, we analyze impacts over the period 2027-2041.

### 1.3.2 *Differences between the Final and Proposed Action*

The amendments to GACT 6B, MACT R, and NSPS XXa are being finalized as proposed. EPA updated costs and emissions impacts to incorporate changes to the economic environment since the proposal. Specifically, the interest rate used to annualize capital costs rose from 3.25% to 7.75% to reflect changes in the bank prime rate, the VOC recovery credit used to value gasoline product recovery was updated to reflect the 2021 wholesale price of gasoline, and the dollar-year was updated from 2019 to 2021 to reflect recent inflation. The VOC benefit-per-ton (BPT) estimates used to monetize VOC emission reductions in Chapter 4 were updated to reflect the most recent estimates published in January 2023 (U.S. EPA, 2023c). Finally, the analysis period was adjusted from 2026-2040 to 2027-2041 to account for the final signature of the action occuring later than originally anticipated.

### 1.3.3 *GACT 6B*

#### *1.3.3.1 Options Examined in this RIA*

The technology review for NESHAP GACT 6B identified improvements in environmental control technology and emissions performance of loading racks, storage tanks, equipment leak detection and repair, and cargo tank vapor tightness. As a result, the EPA is finalizing decisions concerning the technology review to revise requirements for storage tanks, loading operations, and equipment leaks. The current and final standards for each emissions source and facility covered by GACT 6B are listed in Table 1-1 below.

**Table 1-1: Current and Final Standards for NESHAP GACT 6B**

| Emissions Source | Facility | Current Standard | Final Standard |
|---|---|---|---|
| Loading Racks | Small Bulk Terminal (<250,000 gallons per day (gpd), >20,000 gpd) | Submerged fill | Submerged fill |
| | Large Bulk Terminal (>250,000 gpd) | 80 mg/L | 35 mg/L |
| | Bulk Plant (< 20,000 gpd) | Submerged fill | Require vapor balancing system |
| Storage Tanks | Regular Tanks | Compliance with NSPS Kb except for secondary seal on internal floating roof (IFR) tanks and some fittings controls | Require NSPS Kb fitting controls for external floating roof (EFR) Tanks and LEL monitoring for IFR Tanks |
| | Surge Control Tanks | Require fixed roof tanks | Require fixed roof tanks |
| Equipment Leaks | Bulk Terminals, Bulk Plants, Pipeline Breakout Stations, Pipeline Pumping Stations | Monthly AVO inspections | Annual instrument monitoring |
| Cargo Tank Vapor-tightness | Bulk Terminals and Bulk Plants | Maximum allowable pressure loss during certification of 3" water column (WC) for large bulk terminals only | Maximum allowable pressure loss during certification of 0.5" - 1.25" WC |

#### *1.3.3.2 Overview of Costs and Benefits for the Final Options*

The final amendments to GACT 6B are projected to reduce VOC emissions by about 40,000 short tons per year. VOC emissions, in conjunction with $NO_x$ and in the presence of sunlight, form ground-level ozone ($O_3$). The EPA monetized the projected benefits of reducing VOC emissions in terms of the value of avoided ozone-attributable deaths and illnesses. The equivalent annualized value (EAV) of monetized ozone benefits related to VOC emissions reductions is greater than $100 million per year, as seen in Table 1-2, based on avoided ozone-attributable deaths and illnesses. The EAV represents a flow of constant annual values that would yield a sum equivalent to the present value (PV). The maximum estimated undiscounted benefits occur in 2041 ($170 million).

Table 1-2 also presents projected monetized health benefits, non-monetized benefits, emissions reductions, climate disbenefits, compliance costs, and net benefits from the final amendments to GACT 6B. Monetized values are calculated as present values of impacts from

2027 through 2041, discounted to 2024 and measured in 2021 dollars. The projected climate disbenefits are caused by increased electricity usage associated with emissions controls on loading racks at bulk terminals, which are expected to cause secondary emissions increases of $CO_2$, $NO_2$, $SO_2$, and CO. Only the disbenefits associated with increased $CO_2$ emissions have been monetized for this RIA. Certain control options analyzed in this RIA lead to gasoline vapor recovery, which has been monetized as product recovery credits. Net compliance costs are calculated as total compliance costs minus product recovery credits. For a discussion of product recovery, see Section 3.2.6. The net compliance costs of the final amendments to GACT 6B are negative, meaning the value of projected product recovery exceeds the projected compliance costs. Net benefits are projected to be positive using both estimates of ozone health benefits and both 3 percent and 7 percent social discount rates. Further, while benefits from HAP reductions and VOC reductions outside of the ozone season (May-September) have not been monetized for this action, EPA expects these benefits are positive. The unmonetized effects also include disbenefits from secondary emissions increases of $NO_2$, $SO_2$, and CO resulting from increased electricity usage associated with emissions controls on loading racks at bulk gasoline terminals and benefits from avoiding reduced growth and/or biomass production in sensitive trees, reduced yield and quality of crops, visible foliar injury, changed to species composition, and other changes in ecosystems and associated ecosystem services. As mentioned earlier, we calculate cost and emissions reductions relative to the baseline for the period 2027-2041.

**Table 1-2: Monetized Benefits, Non-monetized Benefits, Compliance Costs, Emission Changes and Net Benefits for Final Amendments to GACT 6B, 2027-2041 (million 2021$[4])[a]**

| | 3 Percent Discount Rate | | 7 Percent Discount Rate | |
|---|---|---|---|---|
| | PV | EAV | PV | EAV |
| Health Benefits[b] | $200<br>and<br>$1,600 | $17<br>and<br>$140 | $120<br>and<br>$980 | $13<br>and<br>$110 |
| Climate Disbenefits (3%)[c] | $30 | $2.5 | $30 | $2.5 |
| Net Compliance Costs[d] | -$70 | -$6.0 | -$50 | -$5.0 |
| *Compliance Costs* | *$230* | *$19* | *$160* | *$18* |
| *Value of Product Recovery* | *$300* | *$25* | *$210* | *$23* |
| Net Benefits | $240<br>and<br>$1,600 | $21<br>and<br>$140 | $140<br>and<br>$1,000 | $16<br>and<br>$110 |
| Emissions Reductions (short tons) | 2027-2041 Total | | | |
| VOC | 605,000 | | | |
| HAP | 31,000 | | | |
| Secondary Emissions Increases (short tons) | 2027-2041 Total | | | |
| $CO_2$ | 490,000 | | | |
| $NO_2$ | 280 | | | |
| $SO_2$ | 0.67 | | | |
| CO | 1,300 | | | |
| Non-monetized Benefits | HAP benefits from reducing 31,000 short tons of HAP from 2027-2041 | | | |
| | Climate and health disbenefits of reducing nitrogen oxides ($NO_2$) by 280 short tons, sulfur dioxide emissions ($SO_2$) by 0.67 short tons, and carbon monoxide by 1,300 short tons from 2027-2041 | | | |
| | Visibility effects | | | |
| | Reduced vegetation and ecosystem effects | | | |

[a] Totals may not sum due to independent rounding. Numbers rounded to two significant digits unless otherwise noted.

[b] Monetized health benefits include ozone related health benefits associated with reductions in VOC emissions. The health benefits are associated with several point estimates and are presented at real discount rates of 3 and 7 percent. The two benefits estimates are separated by the word "and" to signify that they are two separate estimates. The estimates do not represent lower- and upper-bound estimates. Disbenefits from additional CO2 emissions resulting from application of control options are monetized and included in the table as climate disbenefits. Benefits from HAP reductions and VOC reductions outside of the ozone season remain unmonetized and are thus not reflected in the table. The unmonetized effects also include disbenefits resulting from the secondary impact of an increase in $NO_2$, $SO_2$, and CO emissions. Please see Section 4.6 for more discussion of the climate disbenefits.

[c] Climate disbenefits are based on changes (increases) in $CO_2$ emissions and are calculated using four different estimates of the social cost of carbon (SC-$CO_2$) (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 disbenefits associated with the average SC-$CO_2$ at a 3 percent discount rate; please see Table 4-11 for the monetized disbenefits calculated using all four SC-$CO_2$ estimates. Chapter 4 also includes a discussion of the climate disbenefits calculated using a new set of updated SC-$CO_2$ estimates that were presented in the RIA for EPA's December 2023 final rulemaking on oil and natural gas sector sources.

[d] Net compliance costs are the engineering control costs minus the value of recovered product. A negative net compliance cost occurs when the value of the recovered product exceeds the compliance costs.

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[4] When necessary, dollar figures in this RIA have been converted to 2021$ using the annual GDP Implicit Price Deflator values in the U.S. Bureau of Economic Analysis' (BEA) NIPA Table 1.1.9 found at found at <https://fred.stlouisfed.org/release/tables?rid=53&eid=41158>.

### 1.3.4 *MACT R*

#### *1.3.4.1 Options Examined in this RIA*

The technology review for NESHAP MACT R identified improvements in environmental control technology and emissions performance of storage tanks, equipment leak detection and repair, and cargo tank vapor tightness. As a result, the EPA is finalizing decisions concerning the technology review to revise requirements for storage tanks, equipment leak detection and repair, and cargo tank vapor tightness. The current and final standards for each emissions source and facility covered by MACT R are listed in Table 1-3 below.

**Table 1-3: Current and Final Standards for MACT R**

| Emissions Source | Facility | Current Standard | Final Standard |
|---|---|---|---|
| Loading Racks | Bulk Terminal | 10 mg/L | 10 mg/L |
| Storage Tanks | Bulk Terminals and Pipeline Breakout Stations | Compliance with NSPS Kb except for some fitting controls | Require NSPS Kb fitting controls for EFR Tanks and LEL monitoring for IFR Tanks |
| Equipment Leaks | Bulk Terminals and Pipeline Breakout Stations | Monthly AVO inspections | Semiannual instrument monitoring |
| Cargo Tank Vapor-tightness | Bulk Terminals | Maximum allowable pressure loss during certification of 1" - 2.5" WC | Maximum allowable pressure loss during certification of 0.5" - 1.25" WC |

#### *1.3.4.2 Overview of Costs and Benefits for the Final Options*

Table 1-4 presents projected monetized health benefits, non-monetized benefits, compliance costs, and emissions reductions from the final amendments to MACT R. Monetized values are calculated as present values from 2027 through 2041, discounted to 2024 and measured in 2021 dollars. No secondary emissions impacts are expected from the final amendments to MACT R because there are no final changes to standards for loading racks at major source bulk gasoline terminals. Therefore, there are therefore no projected climate or other disbenefits. Net benefits are projected to be negative using short-term ozone benefits and positive based on long-term ozone benefits using both a 3 percent and a 7 percent social discount rate. Also, while benefits from HAP reductions and VOC reductions outside of ozone season have not been monetized for this action, EPA expects these benefits are positive. Non-monetized benefits also include benefits from avoiding reduced growth and/or biomass production in sensitive trees, reduced yield and quality of crops, visible foliar injury, changed to species composition, and other changes in ecosystems and associated ecosystem services. As mentioned earlier, we calculate cost and emissions reductions relative to the baseline for the period 2027-2041.

**Table 1-4: Monetized Benefits, Non-monetized Benefits, Compliance Costs, and Emissions Reductions for Final Amendments to MACT R, 2027-2041 (million 2021$)[a]**

| | 3 Percent Discount Rate | | 7 Percent Discount Rate | |
|---|---|---|---|---|
| | PV | EAV | PV | EAV |
| Health Benefits[b] | $11<br>and<br>$87 | $0.89<br>and<br>$7.3 | $6.3<br>and<br>$52 | $0.70<br>and<br>$5.8 |
| Net Compliance Costs[c] | $22 | $1.9 | $16 | $1.6 |
| *Compliance Costs* | *$38* | *$3.2* | *$27* | *$2.9* |
| *Value of Product Recovery* | *$16* | *$1.3* | *$11* | *$1.3* |
| Net Benefits | -$11<br>and<br>$65 | -$1.0<br>and<br>$5.4 | -$9.7<br>and<br>$36 | -$0.91<br>and<br>$4.2 |
| Emissions Reductions (short tons) | 2027-2041 Total | | | |
| VOC | 32,000 | | | |
| HAP | 2,000 | | | |
| Non-monetized Benefits | HAP benefits from reducing 2,000 short tons of HAP from 2027-2041 | | | |
| | Visibility effects | | | |
| | Reduced vegetation and ecosystem effects | | | |

[a] Totals may not sum due to independent rounding. Numbers rounded to two significant digits unless otherwise noted.

[b] Monetized benefits include ozone related health benefits associated with reductions in VOC emissions. The health benefits are associated with several point estimates and are presented at real discount rates of 3 and 7 percent. The two benefits estimates are separated by the word “and” to signify that they are two separate estimates. The estimates do not represent lower- and upper-bound estimates. Benefits from HAP reductions and VOC reductions outside of the ozone season remain unmonetized and are thus not reflected in the table.

[c] Net compliance costs are the engineering control costs minus the value of recovered product. A negative net compliance cost occurs when the value of the recovered product exceeds the compliance costs.

### *1.3.4.3 NSPS XX Options Examined in this RIA*

The review of the Standards of Performance for Bulk Gasoline Terminals (NSPS XX) identified improvements in environmental control technology and emissions performance of loading racks, equipment leak detection and repair, and cargo tanks. As a result, the EPA is finalizing NSPS XXa and requirements for loading operations, equipment leaks, and cargo tank vapor tightness. The current and final standards for each emissions source and facility covered by NSPS XX and final NSPS XXa are listed in Table 1-5 below.

**Table 1-5: Current and Final Standards for NSPS XX and NSPS XXa**

| Emissions Source | Facility | Current Standard | Final Standard |
|---|---|---|---|
| Loading Racks | Bulk Terminal - New | 35 mg/L | 1 mg/L |
| | Bulk Terminal - Modified/Reconstructed | 35 mg/L | 10 mg/L |
| Equipment Leaks | Bulk Terminal | Monthly AVO inspections | Quarterly instrument monitoring |
| Cargo Tank Vapor-tightness | Bulk Terminal | Maximum allowable pressure loss during certification of 3" water column (WC) | Maximum allowable pressure loss during certification of 0.5" - 1.25" WC |

### *1.3.4.4 Overview of Costs and Benefits for the Final Options*

Table 1-6 presents projected monetized benefits, non-monetized benefits, climate disbenefits, compliance costs, and emissions reductions from the final NSPS XXa. Monetized values are calculated as present values from 2027 through 2041, discounted to 2024 and measured in 2021 dollars. The projected climate disbenefits are caused by increased electricity usage associated with emissions controls on loading racks at bulk terminals, which are expected to cause secondary emissions increases of $CO_2$, $NO_2$, $SO_2$, and CO. Only the disbenefits associated with increased $CO_2$ emissions have been monetized for this RIA. Net benefits are projected to be positive based on both short-term and long-term ozone benefits using both a 3 percent and a 7 percent social discount rate. Also, while benefits from HAP reductions and VOC reductions outside of ozone season have not been monetized for this action, EPA expects these benefits are positive. The unmonetized effects also include disbenefits from secondary emissions increases of $NO_2$, $SO_2$, and CO resulting from increased electricity usage associated with emissions controls on loading racks at bulk terminal and benefits from avoiding reduced growth and/or biomass production in sensitive trees, reduced yield and quality of crops, visible foliar injury, changed to species composition, and other changes in ecosystems and associated ecosystem services. We calculate cost and emissions changes relative to the baseline for the period 2027-2041.

## Table 1-6: Monetized Benefits, Non-monetized Benefits, Compliance Costs, and Emissions Changes for Final NSPS XXa, 2027-2041 (million 2021$)[a]

| | 3 Percent Discount Rate | | 7 Percent Discount Rate | |
|---|---|---|---|---|
| | PV | EAV | PV | EAV |
| Health Benefits[b] | $34 and $280 | $2.8 and $24 | $19 and $160 | $2.1 and $17 |
| Climate Disbenefits (3%)[c] | $4.9 | $0.41 | $4.9 | $0.41 |
| Net Compliance Costs[d] | $2.0 | $0.20 | $1.0 | $0.10 |
| *Compliance Costs* | *$52* | *$4.4* | *$34* | *$3.8* |
| *Value of Product Recovery* | *$50* | *$4.2* | *$33* | *$3.7* |
| Net Benefits | $27 and $270 | $2.2 and $23 | $13 and $150 | $1.6 and $16 |
| Emissions Reductions (short tons) | 2027-2041 Total | | | |
| VOC | 110,000 | | | |
| HAP | 4,400 | | | |
| Secondary Emissions Increases (short tons) | 2027-2041 Total | | | |
| $CO_2$ | 77,000 | | | |
| $NO_2$ | 45 | | | |
| $SO_2$ | 48 | | | |
| CO | 0 | | | |
| Non-monetized Benefits | HAP benefits from reducing 4,400 short tons of HAP from 2027-2041<br>Climate and health disbenefits of reducing nitrogen oxides ($NO_2$) by 45 short tons and sulfur dioxide emissions ($SO_2$) by 48 short tons from 2027-2041<br>Visibility effects<br>Reduced vegetation and ecosystem effects | | | |

[a] Totals may not sum due to independent rounding. Numbers rounded to two significant digits unless otherwise noted.

[b] Monetized health benefits include ozone related health benefits associated with reductions in VOC emissions. The health benefits are associated with several point estimates and are presented at real discount rates of 3 and 7 percent. The two benefits estimates are separated by the word "and" to signify that they are two separate estimates. The estimates do not represent lower- and upper-bound estimates. Benefits from HAP reductions and VOC reductions outside of the ozone season remain unmonetized and are thus not reflected in the table. The unmonetized effects also include disbenefits resulting from the secondary impact of an increase in $NO_2$, $SO_2$, and CO emissions. Therefore, monetized climate disbenefits associated with the increased $CO_2$ emissions are not presented in the benefit-cost analysis of this final action conducted pursuant to E.O. 12866. Please see Section 4.6 for more discussion of the climate disbenefits.

[c] Climate disbenefits are based on changes (increases) in $CO_2$ emissions and are calculated using four different estimates of the social cost of carbon (SC-$CO_2$) (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 disbenefits associated with the average SC-$CO_2$ at a 3 percent discount rate; please see Table 4-12 for the monetized disbenefits calculated using all four SC-$CO_2$ estimates. Chapter 4 also includes a discussion of the climate disbenefits calculated using a new set of updated SC-$CO_2$ estimates that were presented in the RIA for EPA's December 2023 final rulemaking on oil and natural gas sector sources.

[d] Net compliance costs are the engineering control costs minus the value of recovered product. A negative net compliance cost occurs when the value of the recovered product exceeds the compliance costs.

### 1.3.5 *All Rules*

Table 1-7 presents projected cumulative impacts for the final NSPS XXa and final amendments to MACT R and GACT 6B. The cumulative net compliance costs of the final amendments are negative, meaning the value of projected product recovery exceeds the projected compliance costs. Net benefits are projected to be positive using both estimates of ozone health benefits and both 3 percent and 7 percent social discount rates. Further, while benefits from HAP reductions and VOC reductions outside of ozone season have not been monetized for this action, EPA expects these benefits are positive. The unmonetized effects also include disbenefits from secondary emissions increases of $NO_2$, $SO_2$, and CO resulting from increased electricity usage associated with emissions controls on loading racks at bulk terminals and benefits from avoiding reduced growth and/or biomass production in sensitive trees, reduced yield and quality of crops, visible foliar injury, changed to species composition, and other changes in ecosystems and associated ecosystem services.  As mentioned earlier, we calculate cost and emissions changes relative to the baseline for the period 2027-2041.

### Table 1-7: Monetized Benefits, Non-monetized Benefits, Compliance Costs, and Emissions Changes for Final NSPS XXa and Final Amendments to MACT R and GACT 6B, 2027-2041 (million 2021$)[a]

| | 3 Percent Discount Rate | | 7 Percent Discount Rate | |
|---|---|---|---|---|
| | PV | EAV | PV | EAV |
| Health Benefits[b] | $240 and $2,000 | $20 and $170 | $140 and $1,200 | $16 and $130 |
| Climate Disbenefits (3%)[c] | $35 | $2.9 | $35 | $2.9 |
| Net Compliance Costs[d] | -$46 | -$3.9 | -$33 | -$3.3 |
| *Compliance Costs* | *$320* | *$27* | *$220* | *$25* |
| *Value of Product Recovery* | *$370* | *$31* | *$250* | *$28* |
| Net Benefits | $250 and $2,000 | $21 and $170 | $140 and $1,200 | $16 and $130 |
| Emissions Reductions (short tons) | 2027-2041 Total | | | |
| VOC | 740,000 | | | |
| HAP | 38,000 | | | |
| Secondary Emissions Increases (short tons) | 2027-2041 Total | | | |
| $CO_2$ | 570,000 | | | |
| $NO_2$ | 330 | | | |
| $SO_2$ | 49 | | | |
| CO | 1,300 | | | |
| Non-monetized Benefits | HAP benefits from reducing 37,000 short tons of HAP from 2027-2041 | | | |
| | Climate and health disbenefits of reducing nitrogen oxides ($NO_2$) by 320 short tons, sulfur dioxide emissions ($SO_2$) by 41 short tons, and carbon monoxide (CO) by 1,300 short tons from 2027-2041 | | | |
| | Visibility effects | | | |
| | Reduced vegetation and ecosystem effects | | | |

[a] Totals may not sum due to independent rounding. Numbers rounded to two significant digits unless otherwise noted.

[b] Monetized health benefits include ozone related health benefits associated with reductions in VOC emissions. The health benefits are associated with several point estimates and are presented at real discount rates of 3 and 7 percent. The two benefits estimates are separated by the word “and” to signify that they are two separate estimates. The estimates do not represent lower- and upper-bound estimates. Benefits from HAP reductions and VOC reductions outside of the ozone season remain unmonetized and are thus not reflected in the table. The unmonetized effects also include disbenefits resulting from the secondary impact of an increase in $NO_2$, $SO_2$, and CO emissions. Please see Section 4.6 for more discussion of the climate disbenefits.

[c] Climate disbenefits are based on changes (increases) in $CO_2$ emissions and are calculated using four different estimates of the social cost of carbon (SC-$CO_2$) (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 disbenefits associated with the average SC-$CO_2$ at a 3 percent discount rate; please see Table 4-13 for the monetized disbenefits calculated using all four SC-$CO_2$ estimates. Chapter 4 also includes a discussion of the climate disbenefits calculated using a new set of updated SC-$CO_2$ estimates that were presented in the RIA for EPA’s December 2023 final rulemaking on oil and natural gas sector sources.

[d] Net compliance costs are the engineering control costs minus the value of recovered product. A negative net compliance cost occurs when the value of the recovered product exceeds the compliance costs.

## 1.4 Organization of this Report

The remainder of this report details the methodology and the results of the RIA. Chapter 2 presents a profile of the gasoline distribution industry. Chapter 3 describes emissions, emissions control options, and engineering costs. Chapter 4 presents the benefits analysis, including a qualitative discussion of the unmonetized benefits associated with HAP emissions reductions and monetization of the disbenefits associated with climate ($CO_2$) emissions increases. Chapter 5 presents analyses of economic impacts, including impacts on small businesses. Chapter 6 presents a comparison of benefits and costs. Chapter 7 contains the references for this RIA. Chapter 8 (Appendix A) presents detailed tables from the market impact analysis found in Section 5.2.2.

# 2 INDUSTRY PROFILE

## 2.1 Introduction

Gasoline plays an important role in the U.S. economy. According to the Energy Information Administration (EIA)[5], gasoline consumption accounted for 58 percent of transportation sector energy consumption, 45 percent of petroleum consumption, and 16 percent of energy consumption in the U.S. in 2021. Over 90 percent of U.S. gasoline consumption fuels light-duty vehicles. The Gasoline Distribution sector delivers finished motor gasoline and blending components from petroleum refineries to end-users. Most of the firms in the sector fall under NAICS classification 424710 (Petroleum Bulk Stations and Terminals) and 486910 (Transportation of Refined Petroleum Products). This section provides an overview of the gasoline distribution industry. Portions of this section are adapted from the *Economic Impact Analysis for the Gasoline Distribution Industry (Area Sources)* (U.S. EPA, 2008).

## 2.2 Supply Side

Finished gasoline and blending components are shipped from petroleum refineries via pipeline, tanker, or barge to bulk distribution facilities that store and dispense gasoline. A variety of downstream marketing arrangements (i.e., wholesale and retail) deliver gasoline to the consumer. This section contains three parts: an overview of the gasoline distribution network, a description of the marketing arrangements which deliver gasoline from bulk distribution facilities to consumers, and a brief examination of industry organization.

### 2.2.1 ***The Gasoline Distribution Network***

The gasoline distribution network consists of storage and transfer facilities that move gasoline from its production to its end consumption. Petroleum refineries produce finished motor gasoline and gasoline blending components from crude oil, which are then shipped via pipeline, barge, or tanker truck to bulk gasoline distribution terminals. Gasoline is the primary product produced by petroleum refineries, with each barrel (42 gallons) of crude oil processed into about

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[5] Energy Information Administration. Gasoline explained: Use of Gasoline. <https://www.eia.gov/energyexplained/gasoline/use-of-gasoline.php>. accessed 3/7/2023.

20 gallons of gasoline.[6] The Gulf Coast region is the petroleum refinery center of the U.S., with the 5 largest refineries operating in either Texas or Louisiana.[7]

Most gasoline is shipped from the refinery via pipeline (~72 percent in 2021[8,9]), with the largest flows moving from the Gulf Coast to the East Coast and Midwest and from the Midwest to the East Coast (see Table 2-1). Figure 2-2 provides a map of the pipeline and water shipping paths typically used for refined petroleum in the U.S. Along the pipeline, two main types of facilities regulate the flow of gasoline: pumping stations, which contain pumps used to maintain the desired pressure and flow of product through the pipeline, and breakout stations, which contain storage tanks to relieve surges and store product for re-injection and continued transportation to bulk distribution terminals.

**Table 2-1: Pipeline Shipments PADD to PADD (Thousand Barrels)**

| From | To | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|
| East Coast | | | | | | |
| | Midwest | 1,200 | 1,000 | 990 | 1,100 | 1,200 |
| Midwest | | | | | | |
| | East Coast | 4,000 | 4,300 | 5,000 | 8,100 | 9,800 |
| | Gulf Coast | 1,400 | 1,500 | 1,600 | 1,900 | 240 |
| | Rocky Mountain | 1,900 | 2,600 | 2,500 | 2,800 | 1,600 |
| Gulf Coast | | | | | | |
| | East Coast | 36,000 | 35,000 | 21,000 | 19,000 | 18,000 |
| | Midwest | 7,600 | 7,000 | 7,800 | 5,500 | 10,000 |
| Rocky Mountain | | | | | | |
| | Midwest | 4,200 | 3,700 | 4,200 | 5,000 | 4,500 |
| | West Coast | 3,900 | 5,700 | 5,100 | 5,000 | 1,600 |
| West Coast | | | | | | |
| | N/A | - | - | - | - | - |

Source: Energy Information Administration. Movements by Pipeline between Pad Districts. <https://www.eia.gov/dnav/pet/pet_move_pipe_a_epm0f_lmv_mbbl_a.htm. 12/30/2021>.
Note: Rounded to two significant digits. Numbers may appear not to add up due to rounding.

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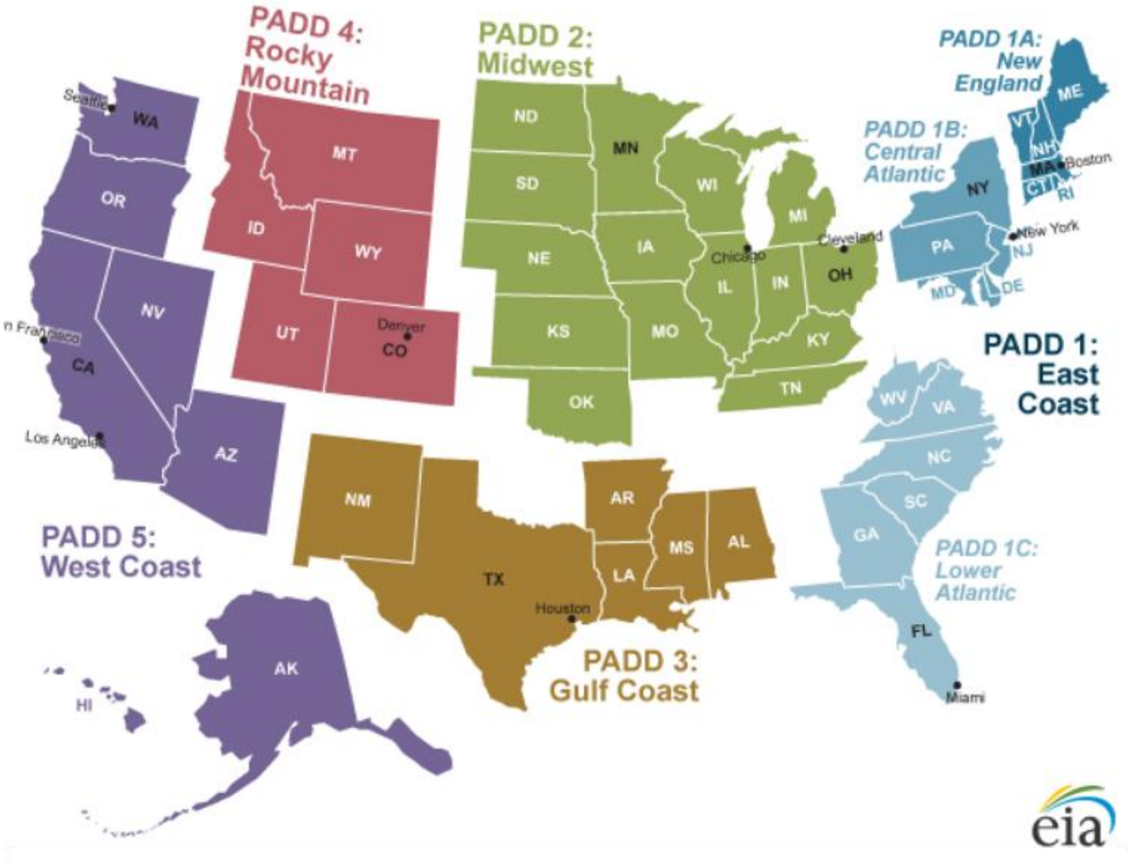
[6] Energy Information Administration. <https://www.eia.gov/tools/faqs/faq.php?id=327&t=9#:~:text=Petroleum%20refineries%20in%20the%20United,gallon%20barrel%20of%20crude%20oil>. Accessed 1/24/2022.

[7] Energy Information Administration. Table 5: Refiners' Total Operable Atmospheric Crude Oil Distillation Capacity. <https://www.eia.gov/petroleum/refinerycapacity/table5.pdf>. accessed 3/7/2023.

[8] Energy Information Administration. Movements by Pipeline between PAD Districts. <https://www.eia.gov/dnav/pet/pet_move_pipe_a_epm0f_lmv_mbbl_a.htm>. accessed 3/7/2023.

[9] Energy Information Administration. Movements by Pipeline, Tanker, Barge, and Rail between PAD Districts. <https://www.eia.gov/dnav/pet/pet_move_ptb_a_epm0f_tnr_mbbl_a.htm>. Accessed 3/7/2023.

Once at a bulk distribution terminal, finished gasoline is transferred directly to a storage tank, while blending components may first be mixed to produce fuel of a desired specification. Due to its proximity to large population centers, the largest volume of bulk gasoline storage capacity is in the East Coast Petroleum Administration Defense District (PADD)[10] (see Table 2-2), followed by the Gulf Coast PADD. Gasoline is loaded via loading racks from storage tanks into large tanker trucks or railcars cargo tanks (typically 8,000-10,000-gallon capacity), which transport gasoline either to retail stations for final sale to consumer or intermediate storage facilities called bulk plants. Bulk plants store gasoline and transfer it via loading rack to tanker trucks for transport to retail gasoline stations or end consumers. They are similar in structure to bulk distribution terminals but contain less storage capacity and handle less throughput. See Figure 2-3 for a general depiction of the gasoline distribution network.



PADD - Petroleum Administration for Defense Districts

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[10] The Petroleum Administration for Defense Districts (PADDs) are geographic aggregations of the 50 States and the District of Columbia into five districts: PADD 1 is the East Coast, PADD 2 the Midwest, PADD 3 the Gulf Coast, PADD 4 the Rocky Mountain Region, and PADD 5 the West Coast. For a map of PADD districts, see Figure 2-1.

**Figure 2-1: Petroleum Administration Defense Districts for Retail Gasoline**
Source: U.S. Energy Information Administration

### Table 2-2: Bulk Gasoline Terminal Working Capacity (Thousand Gallons)

| Year | East Coast | Midwest | Gulf Coast | Rocky Mountain | West Coast | U.S. Total |
|---|---|---|---|---|---|---|
| 2011 | 71,000 | 51,000 | 50,000 | 3,900 | 25,000 | 200,000 |
| 2012 | 74,000 | 50,000 | 54,000 | 3,900 | 24,000 | 210,000 |
| 2013 | 77,000 | 51,000 | 56,000 | 3,900 | 24,000 | 210,000 |
| 2014 | 80,000 | 51,000 | 58,000 | 3,800 | 24,000 | 220,000 |
| 2015 | 82,000 | 50,000 | 59,000 | 3,800 | 24,000 | 220,000 |
| 2016 | 84,000 | 50,000 | 55,000 | 3,900 | 24,000 | 220,000 |
| 2017 | 84,000 | 51,000 | 60,000 | 4,100 | 25,000 | 220,000 |
| 2018 | 84,000 | 52,000 | 62,000 | 4,100 | 25,000 | 230,000 |
| 2019 | 87,000 | 52,000 | 66,000 | 4,100 | 26,000 | 240,000 |
| 2020 | 89,000 | 52,000 | 74,000 | 4,100 | 24,000 | 240,000 |
| 2021 | 91,000 | 54,000 | 73,000 | 4,100 | 26,000 | 250,000 |
| 2022 | 87,000 | 54,000 | 74,000 | 4,200 | 25,000 | 240,000 |

Source: Energy Information Administration, Form EIA-815 "Monthly Bulk Terminal and Blender Report", 2011-2020.
Note: Rounded to two significant digits. Numbers may appear not to add up due to rounding.

**Figure 2-2: System of Pipelines, Ports, and Waterways for Petroleum Product Transportation**
Source: U.S. Energy Information Administration

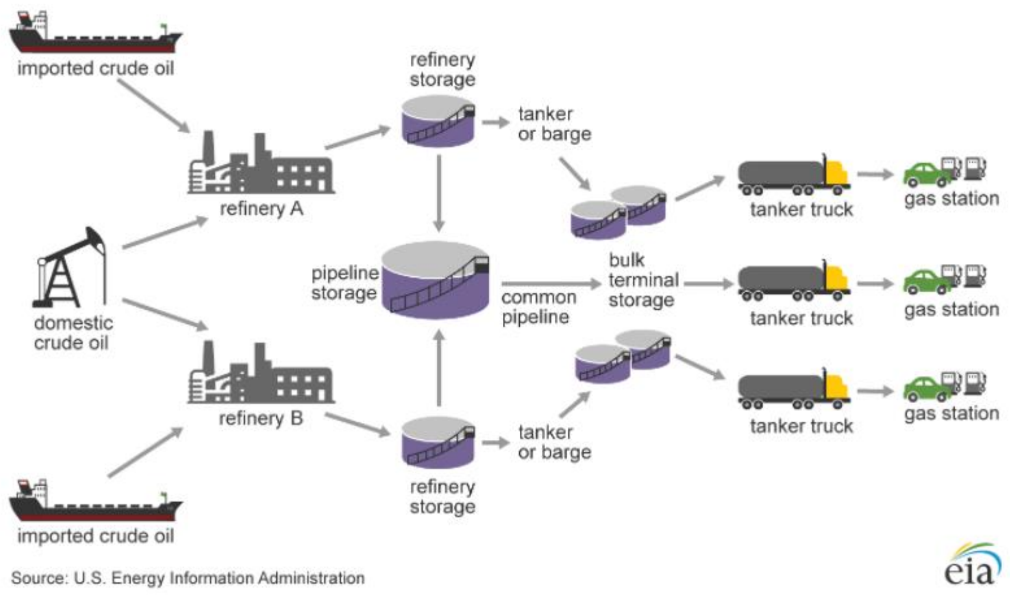

**Figure 2-3: The Gasoline Distribution System**

Source: U.S. Energy Information Administration[11]

### 2.2.2 *Downstream Marketing Arrangements for Refined Petroleum Products*

Once refined petroleum products leave the refinery, they reach consumers through one or more marketing channels. This final step in the supply of refined petroleum products includes two components: wholesale distribution (from product terminals to retail outlets) and retail distribution (to final consumers). Truck transportation is the most common delivery method of gasoline to retail outlets.

There are four primary gasoline marketing channels for wholesale distribution of gasoline. Three of these constitute direct distribution of product:

- Refiner-operated retail outlet: Refiners directly distribute gasoline to their own retail outlets.
- Lessee dealer: Retail outlets are owned by the wholesale distributor but leased to a gasoline dealer.
- Independent retailer: Retail outlets are owned and operated by independent “open” dealers.

The fourth channel comprises indirect distribution of product:

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[11] See <https://www.eia.gov/energyexplained/gasoline/where-our-gasoline-comes-from.php>.

- Jobber: Distributors purchase directly from refiners and then sell products to retail outlets.

The variety of marketing channels illustrates that firms are not all vertically integrated; that is, they are not involved in all stages of gasoline operations from gasoline production, distribution, and ultimate sales to consumers (see Figure 2-4). Table 2-3 shows data for refiner disposition of gasoline by volume to the bulk (sales by contract larger than a truckload), dealer tankwagon (DTW) (price set by the refiner for a truckload of gasoline delivered to a retail gasoline station), and rack (rack sales distributed to jobbers) levels. An increasing percentage of gasoline is being though rack sales to jobbers, with ~84 percent sold via that method in 2021.

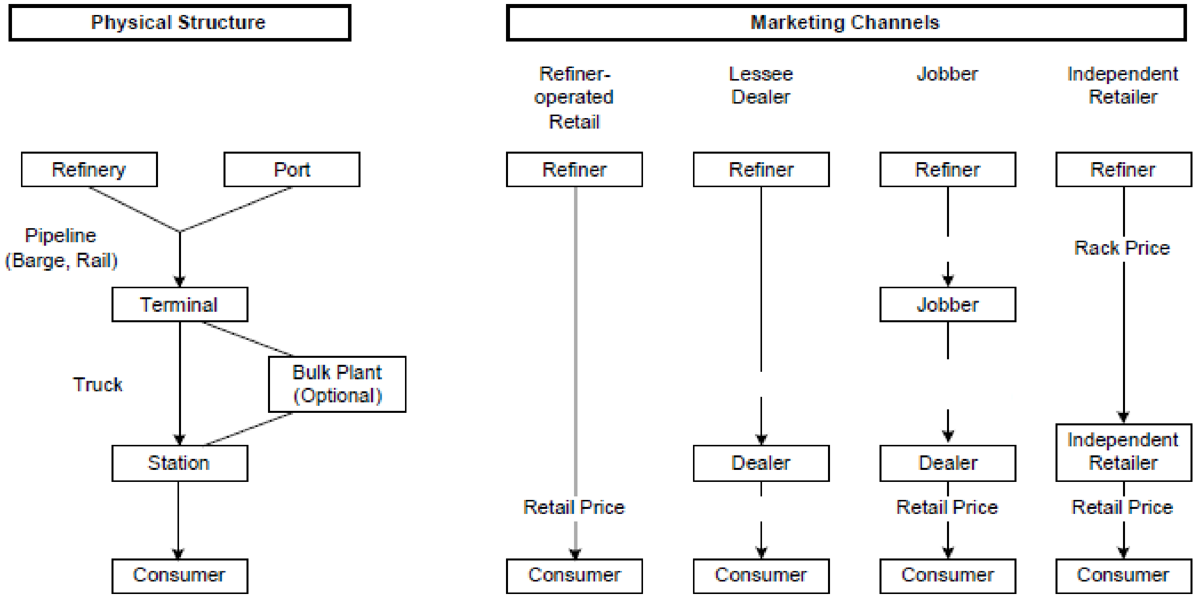

**Figure 2-4: Gasoline Distribution Physical Structure and Marketing Channels**
Source: U.S. Department of Energy, Energy Information Administration (EIA). 2003. “2003 California Gasoline Price Study: Final Report.” Washington, DC: U.S. Department of Energy, Energy Information Administration.

**Table 2-3: Refiner Gasoline Volume by Sales Type (thousand gallons/day)**

| Year | DTW | Rack | Bulk | Total Wholesale |
|---|---|---|---|---|
| 2011 | 30,000 | 230,000 | 33,000 | 290,000 |
| 2012 | 27,000 | 240,000 | 28,000 | 300,000 |
| 2013 | 28,000 | 240,000 | 25,000 | 290,000 |
| 2014 | 24,000 | 240,000 | 21,000 | 290,000 |
| 2015 | 23,000 | 250,000 | 22,000 | 300,000 |
| 2016 | 23,000 | 260,000 | 21,000 | 300,000 |
| 2017 | 22,000 | 260,000 | 18,000 | 300,000 |
| 2018 | 22,000 | 260,000 | 20,000 | 300,000 |
| 2019 | 21,000 | 270,000 | 15,000 | 310,000 |
| 2020 | 17,000 | 230,000 | 9,100 | 260,000 |
| 2021 | 20,000 | 260,000 | 8,500 | 310,000 |

Source: Energy Information Administration. U.S. Motor Gasoline Refiner Sales Volume. <http://www.eia.gov/dnav/pet/pet_cons_refmg_c_nus_epm0_mgalpd_a.htm>. 3/7/2023.
Note: Rounded to two significant digits. Numbers may appear not to add up due to rounding.

### 2.2.3 *Industry Organization*

EPA constructed a facility list for the Gasoline Distribution source category based on the 2017 National Emissions Inventory (NEI), the Toxics Release Inventory, information from the original Gasoline Distribution NESHAP, a bulk terminal list of petrochemical storage facilities from the Internal Revenue Service, the Office of Enforcement and Compliance Assurance's Enforcement and Compliance History Online (ECHO) tool (https://echo.epa.gov), and the Energy Information Administration (EIA). This created an initial list of 1,838 facilities in the Gasoline Distribution source category (hereafter referred to as the "facility list"). The construction of the facility list is described in the preamble for the proposal of this action. EPA ultimately identified the ultimate parent company along with revenue and employment information for 1,705 facilities on the list.[12] While this facility list does not cover all facilities in the sector, it is useful to provide a broad overview. This section provides background on the ultimate parent companies that own the facilities comprising EPA's list.

#### *2.2.3.1 Concentration and Vertical Integration*

Table 2-4 lists the revenue and employment information for the 15 companies in the Gasoline Distribution sector that own the most facilities. Collectively, these firms own ~52 percent of the facilities on the list and averaged $93 billion in revenue in 2020 (measured in

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[12] Revenue and employment information was collected through manual search of D&B Hoover's database in 2021. For the purposes of the final rule, revenues were adjusted to dollar-year 2021.

2021$). All these firms are multinational in operation and vertically integrated, operating in at least two of the following sectors: petroleum extraction, petroleum refining, refined petroleum product transportation, refined petroleum product storage and distribution, or refined petroleum sales. The first two firms on the list provide good examples. Buckeye Partners is heavily active in both transportation and storage of refined petroleum products, owning over 6,000 miles of pipeline and over 100 petroleum product terminals.[13] Marathon Petroleum Corporation is vertically integrated along most of the gasoline supply chain, owning refineries, pipeline facilities, bulk petroleum terminals, and retail gasoline stations.[14] In addition to providing transport and storage of gasoline, at least 8 of these companies also engage in major petroleum refining or extraction operations (Marathon Petroleum Corporation, Phillips 66, Citgo, Royal Dutch Shell, Koch Industries, Chevron, Saudi Aramco, and Exxon Mobil). The top 50 ultimate parent companies on the Facility List own 79 percent of the facilities on the list and averaged $46 billion in revenue in 2020, with a minimum company revenue of $47 million (in 2021$). This shows that the Gasoline Distribution sector is characterized by a substantial degree of vertical integration and is suggestive of a moderately concentrated industry (while there are many active firms, a small minority of them control more than half the market).

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[13] <https://www.buckeye.com/business-operations/>, accessed 1/20/2022.

[14] <https://www.marathonpetroleum.com/Operations/>, accessed 1/20/2022.

**Table 2-4: 15 Largest Gasoline Distribution Parent Companies by Facilities Owned**

| Company | 2020 Revenue (million 2021$) | 2020 Employment | Facilities Owned |
|---|---|---|---|
| Hercules Intermediate Holdings LLC (Buckeye Partners LP) | $4,300 | 1,800 | 125 |
| Marathon Petroleum Corporation | $130,000 | 60,000 | 117 |
| Kinder Morgan Inc | $11,000 | 10,000 | 97 |
| Magellan Midstream Partners | $2,500 | 1,800 | 91 |
| Energy Transfer LP | $40,000 | 12,000 | 65 |
| NGL Energy Partners LP | $7,800 | 1,400 | 65 |
| Nustar Energy LP | $1,500 | 1,400 | 59 |
| Phillips 66 | $68,000 | 14,000 | 54 |
| PDV America Inc (Citgo) | $27,000 | 4,100 | 48 |
| Royal Dutch Shell | $360,000 | 83,000 | 36 |
| Koch Industries | $120,000 | 100,000 | 30 |
| Chevron Corporation | $98,000 | 48,000 | 26 |
| Apex Holding Company | $220 | 1,200 | 26 |
| Saudi Aramco | $340,000 | 68,000 | 25 |
| Exxon Mobil Corporation | $190,000 | 74,000 | 25 |

Source: EPA Gasoline Distribution Facility List, D&B Hoover's Database.

The National Renewable Energy Laboratory (NREL) (2016) used non-public data from the Oil Price Information Service (OPIS) to characterize terminal ownership by five company types (major examples of the company type described in parentheses):

- Oil: Vertically integrated companies that explore and drill for oil and refine it. These companies may also own pipelines (Chevron).
- Pipeline: Companies that own pipelines and lease storage space to customers at terminals (Buckeye Partners, Kinder Morgan, Magellan)
- Refinery: Companies that own refineries and terminals. These companies may also own pipeline (Marathon Petroleum, Royal Dutch Shell, Saudi Aramco, Phillips 66).
- Terminal: Companies that own one or more terminals, but do not own pipelines or refineries.
- Other

NREL found that, while comprising only 55 companies, firms in the Oil, Pipeline, and Refinery groups owned about 65 percent of terminals and about 70 percent of terminal capacity. Terminal companies owned roughly 31 percent of terminals and 29 percent of capacity, with the remainder of both owned by firms in the Other category.

#### *2.2.3.2 Entry Barriers*

Entry into the pipeline business requires significant capital investments. In addition, it often takes years to acquire the necessary approvals and complete construction of a new pipeline. An entrant into product terminals is faced with relatively high capital costs to acquire and install storage tanks and to design, acquire, and install a loading rack. Once operating, however, terminals exhibit scale economies, because as storage volume increases, the cost of operating declines. Other entry barriers for terminals include zoning and environmental permit issues, which can make the time span for opening a new terminal lengthy. One deterrent to entry into product terminals is excess capacity. Existing capacity can meet periods of high terminal demand without large price increases for terminal service; incentives to invest in new terminal capacity tend to be reduced without these price signals.

#### *2.2.3.3 Employment*

The US Census Bureau collects data on NAICS classifications 424710 (Petroleum Bulk Stations and Terminals) and 486910 by enterprise size (see Table 2-5 for NAICS 424710; data on NAICS 486910 is very noisy due to the small number of firms, so we report aggregates below). This information does not reflect ultimate ownership and does not provide complete coverage of bulk gasoline storage and transportation facilities, but still provides a reasonable guide to the number of facilities and the employment level in the sector. In 2017, approximately 66,000 people were employed in about 4,000 establishments classified as Petroleum Bulk Stations and Terminals (NAICS 424710) by the US Census. This is down from 2012, when the Census reported 74,600 people employed in about 4,500 establishments.[15] In combination with Table 2-2, which reports increasing terminal storage capacity per facility over time, this suggests

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[15] US Census Bureau. *County Business Patterns 2012* and *Economic Census 2012*. <https://www.census.gov/data/tables/2012/econ/susb/2012-susb-annual.html>. Accessed 1/24/2022.

consolidation in gasoline storage and transportation as facilities close and existing facilities expand capacity (evidence of the economies of scale discussed in the previous section).

About 4,700 people were employed in 675 establishments classified as engaging in Transportation of Refined Petroleum Products (NAICS 486910).[16] This is roughly flat from 2012 (4,960 people employed in 560 establishments).[17] Taken together approximately, about 71,000 people are employed in the Gasoline Distribution sector across NAICS 424710 and NAICS 486910, although this may miss employment at some smaller bulk plants that are not large enough to be classified under NAICS 424710 or facilities which engage in bulk storage and transportation of gasoline as a secondary business function.

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[16] US Census. *County Business Patterns 2017* and *Economic Census 2017*. <https://www.census.gov/data/tables/2017/econ/susb/2017-susb-annual.html>. Accessed 1/24/2022.

[17] US Census Bureau. *County Business Patterns 2012* and *Economic Census 2012*. <https://www.census.gov/data/tables/2012/econ/susb/2012-susb-annual.html>. Accessed 1/24/2022.

**Table 2-5: NAICS 424710 – Enterprise Size by Employment (2017)**

| Enterprise Size | Firms | Establishments | Employment | Average Receipts (million 2021$) |
|---|---|---|---|---|
| <5 employees | 508 | 511 | 1,099 | $5.4 |
| 5-9 employees | 415 | 425 | 2,731 | $23 |
| 10-14 employees | 267 | 292 | 2,922 | $31 |
| 15-19 employees | 144 | 170 | 2,126 | $37 |
| 20-24 employees | 121 | 139 | 2,233 | $52 |
| 25-29 employees | 83 | 102 | 1,708 | $37 |
| 30-34 employees | 65 | 76 | 1,546 | $59 |
| 35-39 employees | 60 | 79 | 1,788 | $74 |
| 40-49 employees | 92 | 123 | 2,766 | $56 |
| 50-74 employees | 115 | 176 | 4,552 | $250 |
| 75-99 employees | 76 | 145 | 3,834 | $380 |
| 100-149 employees | 83 | 159 | 4,344 | $110 |
| 150-199 employees | 57 | 136 | 3,819 | $260 |
| 200-299 employees | 69 | 169 | 4,267 | $140 |
| 300-399 employees | 27 | 77 | 3,719 | $440 |
| 400-499 employees | 15 | 65 | 2,131 | $590 |
| 500-749 employees | 36 | 96 | 3,422 | $1,400 |
| 750-999 employees | 16 | 85 | 1,511 | $1,200 |
| 1,000-1,499 employees | 22 | 157 | 2,449 | $650 |
| 1,500-1,999 employees | 7 | 232 | 1,800 | $1,100 |
| 2,000-2,499 employees | 6 | 35 | 1,092 | $4,600 |
| 2,500-4,999 employees | 20 | 206 | 4,212 | $3,500 |
| 5,000+ employees | 30 | 295 | 6,190 | $10,000 |

Source: US Census. *County Business Patterns 2017* and *Economic Census 2017*. <https://www.census.gov/data/tables/2017/econ/susb/2017-susb-annual.html>. Accessed 1/24/2022.
Note: Based on Census definitions, an establishment is a physical location at which business is conducted or services/industrial operations are performed. A firm is a business organization consisting of one or more domestic establishments in the same geographic area and industry that were specified under common ownership or control. An enterprise may have establishments in many different industries, so employment for an enterprise within NAICS 424710 may be lower than total employment at an enterprise.

## 2.3 Demand Side

Table 2-6 below shows U.S. gasoline consumption from 2011 to 2021. The U.S. consumed about 135 billion gallons of gasoline in 2021. The Federal Highway Administration (FWHA) distinguishes gasoline consumption by use: highway and nonhighway. In 2021, about

92 percent was consumed for highway use. The remaining 8 percent is for nonhighway use (i.e., lawn and garden equipment and marine uses).[18]

**Table 2-6: U.S. Gasoline Consumption, 2011-2021 (billion gallons)**

| Year | Quantity |
|---|---|
| 2011 | 134.18 |
| 2012 | 133.10 |
| 2013 | 135.56 |
| 2014 | 136.76 |
| 2015 | 140.70 |
| 2016 | 142.82 |
| 2017 | 142.98 |
| 2018 | 143.01 |
| 2019 | 142.71 |
| 2020 | 123.39 |
| 2021 | 135.15 |

Source: Energy Information Administration, https://www.eia.gov/dnav/pet/PET_SUM_SNDW_A_EPM0F_VPP_MBBLPD_W.htm, 3/7/2023.

The Energy Information Administration projects motor gasoline consumption by sector in their “Annual Energy Outlook 2023” (AEO 2023). This structure is consistent with the National Energy Modeling System (NEMS) used to generate forecasts for AEO 2023. Motor gasoline consumption is classified by three end-use sectors:

- Commercial: Commercial-sector consumption encompasses business establishments that are not engaged in industrial or transportation activities.
- Industrial: The industrial sector includes energy consumption for fuels and feedstocks for 15 manufacturing industries and 6 nonmanufacturing industries. This includes agriculture, mining, construction, and manufacturing industries.
- Transportation: The transportation sector includes consumption of transportation-sector fuels by transportation mode (light-duty vehicle, air travel, freight transport).

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[18] Department of Transportation. Federal Highway Administration. *Highway Statistics 2021*. Available here: <https://www.fhwa.dot.gov/policyinformation/statistics/2021/>

> The NEMS Transportation Sector Demand Module models a variety of vehicle types, sizes, fuels, and technology configurations for each class of transportation.

Transportation consumes the bulk of gasoline energy usage, and this is projected to continue over the next two decades as shown below in Table 2-7. Demand from light-duty vehicles is projected to fall by about 1 percent per year through 2050, as electric vehicles gain market share.

**Table 2-7: Motor Gasoline Projected Consumption by Sector, Selected Years (quadrillion BTUs)**

| Sector | 2023 | 2028 | 2033 | 2038 | 2040 |
|---|---|---|---|---|---|
| Commercial | 0.39 | 0.39 | 0.39 | 0.39 | 0.39 |
| Industrial | 0.29 | 0.29 | 0.28 | 0.29 | 0.30 |
| Transportation | 15.81 | 14.69 | 13.58 | 12.86 | 12.61 |
| *Light-duty vehicles* | 14.44 | 13.42 | 12.23 | 11.42 | 11.11 |
| *Commercial light trucks* | 0.65 | 0.62 | 0.62 | 0.63 | 0.65 |
| *Recreation Boats* | 0.16 | 0.15 | 0.15 | 0.14 | 0.14 |
| *Freight Trucks* | 0.61 | 0.62 | 0.65 | 0.68 | 0.71 |
| *Transit and school buses* | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 |

Source: Energy Information Administration. Annual Energy Outlook 2023. Table 2 and Table 36. March 16, 2023. <https://www.eia.gov/outlooks/aeo/tables_ref.php>. Accessed 3/17/2023.

Transportation choices are a function of tastes, income, gasoline prices, and prices of related goods. Personal automobiles and trucks are the dominant mode of travel in U.S., accounting for about 87 percent of passenger miles traveled in 2019.[19] According to the Bureau of Labor Statistics' Consumer Expenditure Survey, the share of household expenditure was flat from 2016 to 2019 at around 3.3 percent (see Table 2-8) but fell to 2.6 percent from 2019 to 2020 as people reduced travel during the COVID-19 pandemic.[20] Consumer expenditure on gasoline rebounded to very close to its previous level in 2021. The expenditure share is similar across region (see Table 2-9), with consumers in the northeast spending a slightly smaller share of income on gasoline in 2020-2021. There is also a seasonality to gasoline demand, with both

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[19] University of Michigan Center for Sustainable Systems. Personal Transportation Factsheet. 2021. <https://css.umich.edu/factsheets/personal-transportation-factsheet#:~:text=In%20the%20U.S.%2C%20the%20predominant,passenger%20miles%20traveled%20in%202019.&text=The%20U.S.%20has%20less%20than,%2C%20and%204.8%25%20in%20Russia>.

[20] Bureau of Labor Statistics. Consumer Expenditure Survey. <https://www.bls.gov/news.release/cesan.nr0.htm>. Accessed 1/21/2022.

the quantity of gasoline consumed and the price of gasoline tending to rise through the spring and peak at the end of summer.[21]

**Table 2-8: Gasoline Expenditure as Share of Household Expenditure**

| Year | Expenditure Share |
|---|---|
| 2017 | 3.3% |
| 2018 | 3.4% |
| 2019 | 3.3% |
| 2020 | 2.6% |
| 2021 | 3.2% |

Source: U.S. Bureau of Labor Statistics. Consumer Expenditure Surveys 2017-2021. September 2020. <https://www https://www.bls.gov/cex/>. Accessed 3/10/2023.

**Table 2-9: Gasoline Expenditure as a Share of Household Expenditure by Region (2020-2021)**

| All Consumer Units, United States | 2.9% |
|---|---|
| Northeast | 2.3% |
| Midwest | 2.9% |
| South | 3.2% |
| West | 2.9% |

Source: U.S. Bureau of Labor Statistics. Consumer Expenditure Survey. <https://www.bls.gov/regions/midwest/data/consumerexpenditures_selectedareas_table.htm>. September 2021. Accessed 1/24/2022.

Gasoline expenditure is largely driven by price changes. Table 2-10 shows the percentage change in gasoline expenditure along with the percentage in a price index for gasoline (CPI-U Gasoline). The table shows both the price of gasoline is relatively volatile year-to-year, and gasoline expenditure changes roughly proportionally with price. This suggests that consumer demand for gasoline is relatively inelastic (that is, the percent change in consumer demand is somewhat less than the percent change in price). This is in line with the research on the price elasticity of demand for gasoline (see Section 5.2.1.3).

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[21] Energy Information Administration. Gasoline explained: gasoline price fluctuations. 9/9/2021. <https://www.eia.gov/energyexplained/gasoline/price-fluctuations.php#:~:text=Gasoline%20prices%20tend%20to%20increase,operations%2C%20or%20gasoline%20pipeline%20deliveries>. Accessed 1/20/2022.

**Table 2-10: Percentage Change in Gasoline Spending and CPI-U**

| Year | Gasoline Expenditure | CPI-U Gasoline |
|---|---|---|
| 2008 | 14.6 | 16.1 |
| 2009 | -26.8 | -26.9 |
| 2010 | 7.1 | 18.3 |
| 2011 | 24.6 | 26 |
| 2012 | 3.9 | 3.3 |
| 2013 | -5.0 | -2.9 |
| 2014 | -5.5 | -4.0 |
| 2015 | -15.9 | -27.2 |
| 2016 | -9.2 | -11.3 |
| 2017 | 3.1 | 13.1 |
| 2018 | 8.1 | 13.4 |
| 2019 | -1.2 | -3.5 |
| 2020 | -24.8 | -16.3 |
| 2021 | 29.1 | 36 |

Source: U.S. Bureau of Labor Statistics. Consumer Expenditure Survey 2008-2019. <https://www.bls.gov/opub/reports/consumer-expenditures/2021/home.htm>. Accessed 3/10/2023.

Consumers can respond to price changes in gasoline in two general ways. First, they may reduce the number of vehicle miles traveled. If the relative price of gasoline remains higher for long periods, consumers may also consider adjusting their vehicle choice or home location to mitigate the effects of higher prices. For example, they may purchase vehicles with better fuel economy or buy a home closer to work or shopping. It is also likely that current trends towards increased remote work spurred by the COVID-19 pandemic allow greater flexibility with respect to commuting, which could cause people to be more responsive to gasoline prices. They could also switch from gasoline-power vehicles to alternative modes of transportation such as mass transit and/or switch to vehicles that use alternative fuels, such as electric or hybrid-electric vehicles. Electric and hybrid-electric vehicles, while currently owned by about 7 percent of U.S. car owners, constitute a growing share of the U.S. market; registrations of such vehicles increased almost four-fold from 2016 to 2021.[22] AEO 2023 projects electric vehicle market share to rise to about 20 percent by 2050.[23]

## 2.4 Market Conditions

### 2.4.1 *Consumption*

American consumption of gasoline increased about 3.5 percent from 2009 to 2019 and was roughly flat from 2016 to 2019. Gasoline consumption fell sharply from 2019 to 2020 but largely rebounded in 2021 (see Table 2-6). Table 2-11 shows the geographic distribution of consumption by PADD. This distribution was very stable over the period, with the largest share occurring in the East Coast PADD (34 percent in 2021).

**Table 2-11: Distribution of Gasoline Consumption by PADD, 2009-2019**

| Year | East Coast | Midwest | Gulf Coast | Rocky Mountain | West Coast |
|---|---|---|---|---|---|
| 2009 | 36% | 28% | 15% | 3% | 17% |
| 2010 | 36% | 28% | 15% | 3% | 17% |
| 2011 | 34% | 29% | 15% | 3% | 17% |
| 2012 | 34% | 28% | 15% | 3% | 17% |
| 2013 | 34% | 29% | 17% | 3% | 17% |
| 2014 | 33% | 28% | 16% | 3% | 17% |
| 2015 | 35% | 28% | 16% | 4% | 17% |
| 2016 | 35% | 29% | 16% | 4% | 17% |
| 2017 | 35% | 29% | 15% | 4% | 18% |
| 2018 | 35% | 29% | 15% | 4% | 18% |
| 2019 | 35% | 29% | 15% | 4% | 17% |
| 2020 | 34% | 30% | 15% | 4% | 17% |
| 2021 | 34% | 29% | 14% | 4% | 17% |

Source: Energy Information Administration. Supply and Disposition. <http://www.eia.gov/dnav/pet/pet_sum_snd_a_epm0f_mbbl_a_cur.htm>. 4/30/2021.

### 2.4.2 *Prices*

The price of gasoline includes the cost of crude oil, distribution and marketing, refining costs and profits, and federal and state taxes (see Figure 2-5), with the cost of crude oil

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[22] Desilver, Drew. *Today's electric vehicle market: Slow growth in U.S., faster in China, Europe*. Pew Research Center. 6/7/2021. <https://www.pewresearch.org/fact-tank/2021/06/07/todays-electric-vehicle-market-slow-growth-in-u-s-faster-in-china-europe/>. Accessed 1/24/2022.

[23] Source: Energy Information Administration. Annual Energy Outlook 2023. AEO 2023 Release Presentation. March 16, 2023. < https://www.eia.gov/outlooks/aeo/pdf/AEO2023_Release_Presentation.pdf>. Accessed 4/13/2023.

accounting for the largest share (56 percent on average from 2011 to 2020). The other components tend to make of roughly equal shares. The Energy Information Administration[24] reports that as of January 2023 federal excise taxes on gasoline were 18.4 cents per gallon, with state excise taxes averaging 31.6 cents per gallon. States taxes vary widely, from a low of 8 cents per gallon in Alaska to a high of 58 cents per gallon in Pennsylvania in 2021.[25] In total, taxes account for about 17 percent of the price of gasoline, with the cost of crude oil (51 percent), distribution and marketing (15 percent), refining costs and profits (15 percent) accounting for the remainder.

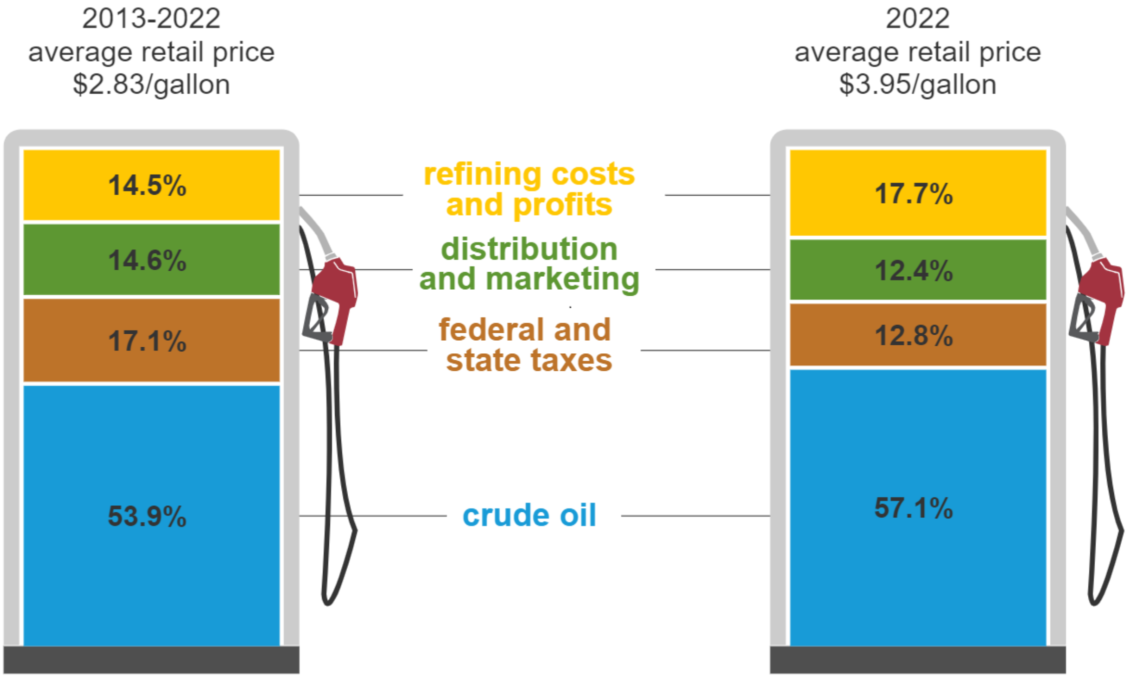

**Figure 2-5: Price of Gasoline by Component**
Source: Energy Information Administration. Gasoline and Diesel Fuel Update.

Gasoline prices also vary geographically (see Table 2-12). The main sources of variation in price by region are state taxes and distance from Gulf Coast petroleum refineries. Gasoline is

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[24] Energy Information Administration. <https://www.eia.gov/tools/faqs/faq.php?id=10&t=10For#:~:text=How%20much%20tax%20do%20we,a%20gallon%20of%20diesel%20fuel%3F&text=Federal%20taxes%20include%20excises%20taxes,per%20gallon%20on%20both%20fuels>. Accessed 3/10/2023.

[25] Federal Highway Administration. *Highway Statistics Series 2021*. <https://www. https://www.fhwa.dot.gov/policyinformation/statistics/2021/mf205.cfm>. Accessed 3/10/2023.

cheapest in the Gulf Coast region and increases in price as it travels north and up the East Coast. Prices are highest on the West Coast, where gasoline taxes are high and pipeline access to Gulf Coast refineries is poor. Certain regions are also required to sell reformulated gasoline in the ozone season due to elevated levels of smog (ozone) and HAP. Reformulated gasoline tends to cost 30 to 35 cents more per gallon than conventional[26], with reformulated gasoline sales concentrated on the West Coast and in dense, urban areas.

**Table 2-12: Gasoline Price by PADD ($2021/gallon)**

| Year | U.S. | East Coast | Midwest | Gulf Coast | Rocky Mountain | West Coast |
|---|---|---|---|---|---|---|
| 2009 | $3.01 | $3.00 | $2.93 | $2.85 | $2.92 | $3.86 |
| 2010 | $3.51 | $3.49 | $3.44 | $3.34 | $3.48 | $4.69 |
| 2011 | $4.33 | $4.34 | $4.28 | $4.15 | $4.20 | $4.83 |
| 2012 | $4.38 | $4.39 | $4.29 | $4.14 | $4.22 | $4.55 |
| 2013 | $4.18 | $4.21 | $4.11 | $3.94 | $4.07 | $4.33 |
| 2014 | $3.94 | $3.98 | $3.85 | $3.69 | $3.89 | $3.49 |
| 2015 | $2.86 | $2.82 | $2.74 | $2.56 | $2.82 | $3.00 |
| 2016 | $2.53 | $2.53 | $2.41 | $2.28 | $2.49 | $3.31 |
| 2017 | $2.79 | $2.80 | $2.65 | $2.53 | $2.76 | $3.73 |
| 2018 | $3.03 | $2.98 | $2.87 | $2.73 | $3.09 | $3.69 |
| 2019 | $2.85 | $2.74 | $2.69 | $2.49 | $2.90 | $3.09 |
| 2020 | $2.36 | $2.30 | $2.18 | $2.01 | $2.45 | $3.97 |
| 2021 | $3.10 | $3.01 | $2.94 | $2.76 | $3.29 | $5.07 |

Source: Energy Information Administration. Weekly Retail Gasoline and Diesel Prices. 1/3/2022. <https://www.eia.gov/dnav/pet/pet_pri_gnd_a_epm0_pte_dpgal_a.htm>Accessed 3/10/2023.

The type of supply-side marketing arrangement affects the wholesale price of gasoline, which indirectly affects retail prices paid by consumers. Refiner-operated stations receive a co-op price—an unobserved, internal transfer price. Lessee and independent retailers receive a DTW price—this price is offered under contract by the wholesaler. Jobbers receive what is known as the rack price. Table 2-13 shows wholesale prices of gasoline by method of refiner

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[26] See Desilver (2019): *Gasoline costs more these days, but price spikes have a long history and happen for a host of reasons.* Pew Research Center. 12/9/2021. <https://www.pewresearch.org/fact-tank/2021/12/09/gasoline-costs-more-these-days-but-price-spikes-have-a-long-history-and-happen-for-a-host-of-reasons/>. Accessed 1/24/2022.

disposition. DTW prices include transportation costs and are thus higher than bulk (sales on contract larger than one truckload) and rack prices.

**Table 2-13: Gasoline Price by Refiner Disposition, Average All Grades ($2021/gallon)**

| Year | DTW | Rack | Bulk |
|---|---|---|---|
| 2009 | $2.38 | $2.20 | $2.10 |
| 2010 | $2.83 | $2.67 | $2.57 |
| 2011 | $3.62 | $3.47 | $3.35 |
| 2012 | $3.71 | $3.47 | $3.40 |
| 2013 | $3.44 | $3.27 | $3.24 |
| 2014 | $3.21 | $2.99 | $2.92 |
| 2015 | $2.44 | $1.93 | $1.85 |
| 2016 | $1.97 | $1.61 | $1.54 |
| 2017 | $2.22 | $1.84 | $1.81 |
| 2018 | $2.60 | $2.10 | $2.09 |
| 2019 | $2.58 | $1.92 | $1.84 |
| 2020 | $1.96 | $1.35 | $1.27 |
| 2021 | $2.80 | $2.15 | $2.09 |

Source: Energy Information Administration. Refiner Gasoline Prices by Grade and Sales Type. 3/10/2023. <https://www.eia.gov/dnav/pet/pet_pri_refmg_dcu_nus_a.htm>. Accessed 1/24/2022.

### 2.4.3 *Trends and Projections*

AEO 2023 estimates that the average annual growth rate for gasoline consumption will be negative (-0.7 percent) from 2022-2050, driven by a fall in demand for gasoline from light-duty vehicles. As shown in Table 2-14, increases in commercial and industrial gasoline usage is projected to be swamped by a decrease in transportation usage, driven by a decrease in gasoline consumption by light-duty vehicles. Table 2-15 contains gasoline price and quantity projections from 2027-2041. These years, as discussed in chapter 3, comprise the baseline period of analysis for this RIA. Gasoline prices rose by about a dollar per gallon on average from 2021 to 2022 ($3.02 to $3.97) according to the Energy Information Administration’s Short-Term Energy Outlook (STEO).[27] The STEO is currently projecting an average price per gallon of $3.36 in 2023 and $3.11 in 2024.

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[27] Energy Information Administration. *Short Term Energy Outlook*. <https://www.eia.gov/outlooks/steo/>. 1/11/2022.

**Table 2-14: AEO 2023 Motor Gasoline Growth Rates by Sector, 2022-2050**

| Sector | | Average Annual Growth Rate |
|---|---|---|
| Commercial | | 0.0% |
| Industrial | | 0.3% |
| Transportation | | -0.8% |
| | *Light-duty vehicles* | -0.9% |
| | *Commercial light trucks* | 0.2% |
| | *Recreation Boats* | -0.6% |
| | *Freight Trucks* | 0.9% |
| | *Transit and school buses* | -0.3% |
| Total | | -0.7% |

Source: Energy Information Administration. Annual Energy Outlook 2023. Table 2 and Table 36. March 16, 2023. <https://www.eia.gov/outlooks/aeo/tables_ref.php>. Accessed 3/17/2023.

**Table 2-15: AEO 2023 Baseline Gasoline Projections, 2027-2041**

| Year | Price ($2022/gallon) | Quantity (billion gallons) |
|---|---|---|
| 2027 | 2.85 | 129.98 |
| 2028 | 2.85 | 128.32 |
| 2029 | 2.86 | 126.44 |
| 2030 | 2.87 | 124.42 |
| 2031 | 2.86 | 122.51 |
| 2032 | 2.88 | 120.68 |
| 2033 | 2.89 | 119.20 |
| 2034 | 2.90 | 117.92 |
| 2035 | 2.90 | 116.66 |
| 2036 | 2.93 | 115.37 |
| 2037 | 2.93 | 114.29 |
| 2038 | 2.94 | 113.36 |
| 2039 | 2.95 | 112.52 |
| 2040 | 2.96 | 111.91 |
| 2041 | 2.96 | 111.41 |

Source: Energy Information Administration. Annual Energy Outlook 2023. Table 12. March 16, 2023.

# 3 EMISSIONS AND ENGINEERING COSTS ANALYSIS

## 3.1 Introduction

In this chapter, we present estimates of the projected emissions changes (reductions and increases) and engineering compliance costs associated with the final action for the 2027 to 2041 period. There are two main components to the analysis of HAP and VOC emission reductions and associated engineering compliance costs. The first component is a set of model plants for each rule, regulated facility, and control option. Model plants are the basis for this analysis due to the large number of affected facilities and the difficulties in conducting an analysis for each affected facility.  Characteristics of the model plants include typical equipment, operating characteristics, and representative factors including baseline emissions and costs, emissions reductions, and product recovery resulting from each control option. The second component is a set of projections of activity data for affected facilities. Cost and emissions impacts are calculated by setting parameters on how and when affected facilities are assumed to respond to a particular regulatory regime, multiplying activity data by model plant cost and emissions estimates, differencing from the baseline scenario, and then summing to the desired level of aggregation. In addition to emissions reductions, some control options result in gasoline product recovery, which can then be sold. Estimates of annualized cost include the value of the product recovery where applicable.

## 3.2 Emissions Points, Controls, and Model Plants

NSPS XX, MACT R, and GACT 6B collectively regulate 4 types of facilities:

1. Bulk Gasoline Terminals
2. Bulk Gasoline Plants
3. Pipeline Breakout Stations
4. Pipeline Pumping Stations

Table 3-1 summarizes the facilities covered by each rule. Each type of facility is discussed briefly below.

**Table 3-1: Regulated Facilities by Rule**

| Facility | NSPS XX | MACT R | GACT 6B |
|---|---|---|---|
| Bulk Gasoline Terminals | X | X | X |
| Bulk Gasoline Plants | | | X |
| Pipeline Breakout Stations | | X | X |
| Pipeline Pumping Stations | | | X |

Note: NSPS XX does not cover gasoline storage at bulk gasoline terminals

### *3.2.1.1 Bulk Gasoline Terminals*

A bulk gasoline terminal is a gasoline storage and distribution facility that receives gasoline by pipeline, ship, barge, or cargo tank and has a throughput of greater than 75,700 liters per day (approximately 20,000 gallons per day). Once received at a terminal, gasoline is stored in large storage tanks and transferred to cargo tanks via a system of equipment called a loading rack. Once offloaded into cargo tanks, gasoline is transported from the terminal to retail gasoline stations or intermediate storage facilities called bulk plants (discussed in the next section). Bulk gasoline terminals are regulated by NSPS XX, MACT R, and GACT B.

### *3.2.1.2 Bulk Gasoline Plants*

Bulk gasoline plants are like bulk gasoline terminals. They receive gasoline by pipeline, ship, barge, or cargo tank, store the gasoline received in storage tanks, and transfer it to tanker trucks via a loading rack. However, bulk gasoline plants handle throughput less than 20,000 gallons per day. They therefore have fewer and smaller storage tanks and smaller loading racks than bulk gasoline terminals. Due to their smaller scale, bulk gasoline plants are area sources of HAP and are regulated under GACT 6B.

### *3.2.1.3 Pipeline Breakout Stations*

Pipeline breakout stations are facilities along a refined petroleum pipeline which contain storage vessels used to relieve surges or receive and store gasoline from the pipeline for re-injection and continued transportation by pipeline or to other facilities. Pipeline breakout stations vary in size and emissions and are regulated by both MACT R and GACT 6B.

### *3.2.1.4 Pipeline Pumping Stations*

Pipeline pumping stations are facilities along a pipeline containing pumps to maintain the desired pressure and flow of product through the pipeline. They do not contain gasoline storage tanks other than surge control tanks. Pipeline pumping stations are area sources of HAP and regulated under GACT 6B.

### 3.2.2 *Emission Points at Regulated Facilities*

This section characterizes emission points at regulated facilities and the emissions controls evaluated by the NESHAP technology reviews and NSPS review.

#### *3.2.2.1 Loading Racks*

Gasoline stored at bulk terminals and bulk plants is pumped through metered loading areas, or loading racks, into tanker trucks. A loading rack consists of a platform, loading arms (which connect to the tank truck for fuel transfer), pumps, meters, valves, and piping to transfer gasoline from the storage tank to the receiving cargo tank. The process of loading gasoline causes displacement of gasoline vapors, which lead to VOC and HAP emissions.

The gasoline loading arm can connect to the tanker cargo tank at the top of the tank (top loading) or the bottom of the tank (bottom loading). Top loading may occur directly through a top loading fill pipe (splash loading) or through a connected downspout that places the entry flow near the bottom of the tank (submerged fill). Splash loading creates turbulence that leads to increased emissions. Bottom loading leads to submerged fill and reduced turbulence. One method of controlling VOC emissions relative to splash loading is to use submerged fill top loading or bottom loading.

In addition to submerged loading, emissions from loading operations can be controlled through conveying displaced vapor through a closed vent system to a control device or fuel gas system, and vapor balancing. The closed vent system uses piping to capture displaced vapor from the cargo tank and route it either to a control device or to a fuel system for combustion. Vapor balancing systems capture displaced vapor and route it through piping back to the storage tank. Vapor balancing can only be used with fixed roof storage tanks, and thus vapor balancing is not an option at most gasoline distribution facilities other than bulk gasoline plants (see the next section).

This technology review MACT R and GACT 6B and the review of NSPS XX evaluated thermal/vapor combustion units (VCUs), carbon adsorption vapor recovery units (VRUs), flares, and refrigerated condensers based on both splash loading and submerged loading. While submerged loading is not required explicitly by current NESHAP (except for certain area source facilities) and NSPS, it is consistent with management best-practices and is thought to be the predominant method of loading. For this reason, it is assumed that facilities already practice submerged loading in the baseline and all costs and emissions impacts are incremental to submerged loading. Emissions limits at gasoline loading racks are specified in terms of allowable emissions in milligrams of TOC per liter of gasoline loaded (mg/L).

#### *3.2.2.2 Storage Tanks*

Gasoline is stored at bulk gasoline terminals, bulk gasoline plants, and pipeline breakout stations in large storage tanks. These storage tanks have either fixed or floating roofs. A fixed roof tank uses a cone or dome shaped roof that is permanently affixed to the tank shell. Floating roof tanks have a roof that sits on top of the stored gasoline and rises or falls throughout the day based on the varying amount of gasoline stored in the tank. The floating roof of the tank may be either external (EFR) or internal (IFR). An EFR consists of a cylindrical steel shell with a deck that floats on the gasoline and rises and falls with the liquid level. An IFR has both a permanent roof and a deck that floats either on the gasoline's surface or several inches above.

Most emissions from fixed roof tanks are breathing losses and emptying losses. Breathing loss is the expulsion of vapor from a tank's vapor space that has expanded or contracted due to changes in temperature or pressure. These losses occur without any change to the gasoline level of the tank. Emptying loss occurs when air drawn into the tank during gasoline removal saturates with hydrocarbon vapor and expands past the fixed capacity of the tank, overflowing through a pressure valve. Collectively, breathing and emptying losses are called "working" losses. Fixed roof tanks may use vents to control breathing losses and vapor balancing systems to control emptying losses.

Gasoline storage facilities use floating-roof tanks to control working losses. A typical EFR consists of a cylindrical steel shell with a deck that floats on the surface of the gasoline, completely covering it except for a small gap. A seal attached to the roof slides along the shell wall as the roof is raised and lowered. An IFR is similar but also contains a permanently affixed roof at the top of the tank and may have a noncontact roof that floats inches above the surface of the gasoline on pontoons. The largest source of emissions from floating roof tanks is standing-storage loss, often caused by an improper fit between the seal and the tank shell or roof fittings.

Emissions from floating roof tanks are controlled by mandating a certain type of seal and/or roof fittings. As part of the technology review for major sources (RTI, 2021) and area sources (RTI, 2021), EPA identified a new practice for monitoring internal floating roof storage vessels using a lower explosive limit (LEL) monitor to identify floating roofs with poor seals or fitting controls. IFR tanks are much more common than EFR tanks. EPA estimates that approximately 95 percent of the storage tanks in gasoline distribution are IFR tanks. Storage tanks are the largest source of VOC emissions at gasoline distribution facilities.

Storage vessels at bulk gasoline terminals subject to NSPS XX are regulated by NSPS subpart K, Ka, or Kb. MACT R covers all storage tanks with a capacity greater than 20,000 gallons, while NESHAP subpart 6B has primary requirements for tanks with capacity greater than 20,000 gallons and throughput greater than 480 gallons per day or capacity greater than 40,000 gallons irrespective of throughput for bulk terminals and pipeline breakout stations. There are no size specifications for bulk plants, but tanks smaller than 20,000 gallons are required to have a fixed roof. For this reason, storage tanks at bulk gasoline plants have fixed roofs while most other tanks in service in gasoline distribution have floating roofs. The technology review and NSPS review considered a range of options for both IFR and EFR tanks, from maintaining the minimum MACT R/GACT 6B requirements (i.e., baseline requirements) up to requiring control beyond NSPS Kb requirements. NSPS Kb, which was promulgated in 1987, requires a vapor-mounted primary seal, a rim-mounted secondary seal, and fitting controls for IFR tanks. For EFR tanks, NSPS Kb requires a mechanical shoe seal with a rim-mounted secondary seal and fitting controls.[28]

#### *3.2.2.3 Equipment Leaks*

Equipment leaks are fugitive emissions occurring though malfunctioning valves, pumps, hatches, or seals. Loading racks, storage vessels, and other equipment in use at bulk gasoline terminals, bulk plants, pipeline breakout stations, and pipeline pumping stations are all potential sources of fugitive emissions. Fugitive emissions at potential sources are controlled by leak detection and repair (LDAR) programs. Examples of LDAR programs include audio, visual, and olfactory (AVO) monitoring or monitoring at differing frequencies (annual or quarterly, for example) using Method 21 or an optical gas imaging (OGI) device (instrument monitoring).

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[28] NSPS Subpart Kb is currently under review.

Under an LDAR regime, all components in gasoline service at a facility are inspected using the prescribed method. Under either type of regime, if leaks are detected in the normal course of operations, they are required to be repaired. LDAR programs can vary in their emissions control based on their frequency of monitoring (how often is equipment inspected) and efficacy of monitoring (how likely is inspection to detect an occurring leak). Instrument monitoring will detect leaks that cannot be detected by AVO methods.

NSPS XX equipment leak provisions apply only to vapor collection systems, vapor processing systems, and gasoline loading racks at bulk gasoline terminals. NESHAP subpart R and NESHAP 6B apply to all equipment in gasoline service at bulk terminals and pipeline breakout stations and bulk terminals, bulk plants, pipeline pumping stations, and pipeline breakout stations respectively. The technology review and NSPS review evaluated LDAR programs ranging from the current AVO monitoring regime to periodic monitoring with Method 21 or an OGI device with monitoring frequency ranging from annual to bimonthly.

#### *3.2.2.4 Cargo Tanks*

Bulk terminals and bulk plants contain loading racks that transfer gasoline from storage tanks into the cargo tanks of tanker trucks or railcars. Gasoline is a Class 3 flammable liquid and may be transported using “non-pressure” cargo tanks (DOT 406) or “low-pressure” cargo tanks (DOT 407), the requirements for which are expressed in terms of maximum allowable working pressure (MAWP) and pressure-relief valve settings. Given the MAWP requirements for DOT 406 and DOT 407 tanks, gasoline will trigger the pressure-relief valve on DOT 406 tanks under certain circumstances but will never trigger the pressure-relief valve on DOT 407 tanks. There are additional legal restrictions on the transport of Class 3 flammable liquids by railcar (RTI, 2021), and railcar gasoline loading operations are not expressly included in NSPS XX. EPA estimates less than 10 percent of gasoline is transported by railcar.

Tanks are divided into compartments with a hatchway at the top of each. Cargo tanks can be top loaded at a loading rack by opening the hatch cover and dispensing product directly through it. A top-loading vapor head compatible with the hatch allows vapor collection during loading, and a better vapor-tight seal is created when top loading is performed through a top-tight loading adapter mounted in each compartment.

During bottom loading, an internal valve is opened to allow product flow, and vents permit the exit of displaced vapor. Vapor collection systems with bottom loading equipment collect vapors from the vents through a common manifold. The tank truck vapor-recovery line terminates at a connector on the side or rear of the truck.

Emissions occur from cargo tanks due to vapor loss from leaking tank hatches and pressure-relief valve venting. Controlling emissions from cargo tanks typically involves certifying through a pressure-vacuum test that cargo tanks in use at a loading rack have a specified degree of vapor-tightness. There is a trade-off between pressure-release emissions and cargo tank leakage emissions as vapor-tightness requirements are tightened. For example, a tank with a slowly leaking hatch will be less likely to trigger the pressure-relief valve. Tighter vapor tightness standards will therefore lead to more pressure-relief events, and there is a point at which reducing the allowed pressure drop during certification will simply shift emissions from small leaks to emissions from increased pressure-relief valve release events; see the Technical Memo on Loading Racks (RTI, 2023).[29]

Given the allowed vapor-tightness standard, cargo tanks are tested and leaks are repaired when necessary. The NESHAP technology review and NSPS review evaluated standards ranging from maintaining the minimum vapor-tightness requirements of NSPS XX and GACT 6B to requiring vapor-tightness to be certified to a stricter level than final by this action. The allowed pressure changes by tank size examined in this RIA are in Table 3-2.

**Table 3-2: Cargo Tank Vapor-Tightness Certification Standards Examined in this RIA (inches WC)**

| Cargo Tank of Compartment Capacity (gallons) | Current NSPS/GACT Standard | Current MACT Standard | Final Standard[30] | More Stringent Alternative Standard[a] |
|---|---|---|---|---|
| 2,500 or more | 3.00 | 1.00 | 0.50 | 0.20 |
| 2,499 to 1,500 | 3.00 | 1.50 | 0.75 | 0.20 |
| 1,499 to 1,000 | 3.00 | 2.00 | 1.00 | 0.50 |
| 999 or less | 3.00 | 2.50 | 1.25 | 1.00 |

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[29] The technical analyses consist of a set of 7 memos, referred to hereafter as the Technical Memos. The Technical Memos are included in the docket for this final action and are listed in the References (Chapter 0). In the remainder of the RIA, when referring to a specific technical memo, we will refer to it as the Technical Memo on X.

[30] The final standards unify the NSPS/GACT and MACT cargo tank vapor-tightness standards. The final standard matches cargo tank vapor-tightness instituted by the California Air Resource Board (Title 17 CCR § 94014).

[a] This more stringent standard requires allowable pressure drop limits that are less than the allowable precision of EPA Method 27. Further reductions of the vapor tightness requirements beyond those identified in the final standard may not be feasible in practice.

### 3.2.3 *Model Plants*

As discussed in the introduction to this section, the emissions reductions and engineering cost analyses presented in this section rely on a set of model plants. The model plant configurations, including cost and emissions characteristics used to estimate impacts of the final action, are derived from the technical analyses supporting the review of NSPS XX and the technology review of MACT R and GACT 6B. The technical analyses consist of a set of 7 memos, referred to hereafter as the Technical Memos .

The high-level model plants used in the analysis are bulk gasoline terminals, bulk gasoline plants, pipeline breakout stations, and pipeline pumping stations. These high-level model plants have a variety of configurations, which include specifications of model storage tanks and loading racks present at the facility. Each type of model plant used in the analysis is discussed below, beginning with the lower-level model plants.

#### *3.2.3.1 Loading Racks*

Gasoline transfer operations occur at bulk gasoline terminals and bulk gasoline plants. The engineering cost analyses for NSPS XXa, MACT R, and GACT 6B each use a variety of model bulk gasoline terminals, and the analysis for NESHAP 6B uses model bulk gasoline plants. Each of these model plants is assigned a model loading rack, which is used to establish baseline cost and emissions parameters and estimate how a model plant will respond to different emissions controls for gasoline loading operations. Model loading racks are assigned to facilities based on facility throughput. Larger loading racks have more loading arms, greater throughput per arm, operate more days per year, and operate longer in a given day.

Model loading racks are also distinguished by their baseline emissions levels and the control method used to achieve it. The current emissions limits vary by rule, and this is reflected in the assignment of model loading racks to bulk plants and terminals. For example, loading racks at major source model bulk terminals are assumed to be controlled to 10 mg/L, while loading racks at area source model large bulk terminals are assumed to be controlled to at least 80 mg/L. It is also assumed some model bulk plants and terminals are equipped with loading racks that control emissions beyond the minimum level. Some model bulk plants are assumed to already be using vapor balancing systems to control loading emissions, whereas some area source model bulk terminals are assumed to exceed 80 mg/L of control by using a vapor recovery or vapor combustion system. Further, a portion of the facilities to undergo modification or reconstruction are assumed to be meeting either 10 mg/L, 35 mg/L, or 80 mg/L prior to modification/reconstruction. The current standards and the regulatory options analyzed in this RIA are discussed in Section 3.3 below. The pre-existing method and level of emissions control at a loading rack determines the baseline cost and emissions due to loading operations at a facility and the cost and emissions impacts of more stringent control relative to baseline. For details on the type and distribution of model loading racks at model bulk terminals and plants, see the Technical Memo on Loading Racks.

#### *3.2.3.2 Storage Tanks*

Gasoline storage occurs at bulk gasoline terminals, bulk gasoline plants, and pipeline breakout stations. However, storage tanks at bulk gasoline terminals are not covered by NSPS XX, so model storage tanks do not directly affect cost and emissions at NSPS XXa model bulk terminals. Also, no changes to storage tank controls at bulk plants were considered in either the final standards or the less and more stringent alternative standards (apart from the vapor balancing requirement for gasoline loading operations and the filling of storage vessels). Therefore, this discussion is only relevant to model storage tanks with floating roofs at major and area source model bulk terminals and pipeline breakout stations.

Given the variety of tank sizes and configurations (fixed vs floating roof, internal vs external floating roof) and current storage tank control standards, it was necessary to make assumptions about the type and quantity of tanks present at each model bulk terminal and bulk plant. First, bulk plants are required to used fixed roof tanks, while larger tanks at bulk terminals and pipeline breakout stations are required to have floating roofs. Model storage tanks used in the engineering cost analysis differ along 3 dimensions:

1. Size – 9 levels (ranging from 12,000 to 4,200,000 gallons) for IFR tanks, 7 levels (ranging from 80,000 to 4,200,000 gallons) EFR tanks
2. Internal vs external floating roof (2 levels)

3. Kb fitting controls included vs non-Kb compliant (2 levels)

There are 32 main model storage tank configurations, and these are distributed to model bulk terminals and model pipeline breakout stations based on model terminal throughput and assumptions about the underlying population of storage tanks in gasoline service. For further details, see the Technical Memo on Storage Tanks (RTI, 2023).

#### *3.2.3.3 Cargo Tanks*

The final action proposes new standards for vapor-tightness of cargo trucks servicing bulk gasoline terminals and bulk gasoline plants. To estimate the costs and emissions impacts of these final standards and assign them to specific rules, there are two steps:

1. Estimate the nationwide impacts of final standards based on an assumed distribution of model cargo tanks.
2. Assign these impacts to NSPS XXa, MACT R, and GACT 6B facilities based on the fractional distribution of total throughput serviced by bulk terminals and plants covered by each rule.

For example, suppose one third of gasoline throughput is assumed to occur at NSPS XXa affected model terminals, one third is assumed to occur at MACT R affected model terminals, and one third is assumed to occur at GACT 6B model bulk terminals and model bulk plants. In this scenario, one third of the cost and emissions impact of each cargo tank option would be assigned to each rule. Throughput at model bulk terminals and plants is discussed below.

For step 1, 5 model cargo tanks were used, ranging in size from 600 to 8,500-gallon tank capacity. Each tank size had an assumed nationwide distribution, and each tank was assumed to undergo 10 pressure-relief device releases per day. For discussion of cargo tank controls and the assumed distribution of tanker trucks, see the Technical Memo on Loading Racks (RTI, 2023).

#### *3.2.3.4 Pipeline Pumping Stations*

There are no major source pipeline pumping stations, so all pipeline pumping stations are covered under GACT 6B. There is only one model pipeline pumping station, so all area source pipeline pumping stations are treated equivalently in the engineering cost analysis. For the purposes of assessing equipment leaks, each model pumping station was assumed to have 59 valves, 260 flanges and connectors, and 6 pumps.

#### *3.2.3.5 Pipeline Breakout Stations*

Pipeline breakout stations are covered by MACT R and GACT 6B. Model pipeline breakout stations are distinguished by:

1. Area source vs major source of HAP
2. Throughput level (2 levels – 600,000 and 750,000 gpd)
3. The number of model storage tanks (2 levels – 4 or 5). It assumed that the 600,000 gpd model breakout station uses 4 tanks, while the 750,000 gpd breakout station uses 5 tanks.
4. The distribution of model storage tanks between Kb and non-Kb compliant. 3 different splits between IFRT/EFRT Kb/non-Kb model storage tanks are assumed for each rule/size combination.

This leads to 12 total configurations of model pipeline breakout stations (2 rules x 2 sizes x 3 tank configurations). For the purposes of assessing equipment leaks, each model breakout station was assumed to have 2,980 valves, 5,230 flanges and connectors, and 75 pumps.

#### *3.2.3.6 Bulk Gasoline Plants*

Bulk gasoline plants are all area sources of HAP, so all model plants are covered by GACT 6B for the purposes of the engineering cost analysis. Model bulk plants are all assumed to have throughput of 15,000 gallons of gasoline per day and house two small, fixed roof storage tanks. Model bulk plants are only distinguished by their model loading rack. A model bulk plant may be assigned one of three possible model loading racks:

1. A loading rack with a vapor balancing system (for both deliveries and loading)
2. A loading rack with vapor balancing system for either deliveries or loading (but not both)
3. A loading rack without a vapor balancing system

Model bulk plants were placed into the above three categories based on an assumed distribution of bulk plants within states. In developing the original standards for GACT 6B (Hester and Stephenson, 2006), EPA reviewed state rules to determine what states had regulations controlling emissions at bulk plants. Certain states had rules controlling VOC emissions from loading racks or explicitly requiring vapor-balancing systems. Based on this review, EPA estimated the proportion of bulk plants which already had a vapor-balancing system in place due to existing state requirements. EPA also estimated the proportion of bulk plants that would be exempt from the requirement due to not meeting a throughput threshold of 4,000 gpd as part of this review. The engineering cost analysis contained in this chapter thus assumes that, in the baseline, some bulk plants already have a vapor-balancing system for either deliveries or loading (or both) and that some bulk plants would not meet the throughput threshold required to install a vapor-balancing system. For the distribution of bulk plants, see Table 3-5 in Section 3.2.4. For a discussion of vapor balancing systems and the assumed distribution of loading racks at bulk plants, see the Technical Memo on Loading Racks (RTI, 2023) and supporting documentation. For the purposes of assessing equipment leaks, each model bulk plant was assumed to have 50 valves, 216 flanges and connectors, and 4 pumps.

#### *3.2.3.7 Bulk Gasoline Terminals*

Each rule covers operations of bulk gasoline terminals, so there are different model bulk gasoline terminals associated with each rule. In addition to differing by rule, model bulk terminals differ along five dimensions:

1. Size, determined by gasoline throughput per day and operating days per year
2. Type of model loading rack in the baseline, based on type of control (VCU, VRU, flare, no control) and estimated level of control (no control, 80 mg/L, 35 mg/L, 10 mg/L).
3. Number of tanks
4. Distribution of tanks between IFRT/EFRT and Kb/non-Kb compliant.
5. NSPS XXa only – model plants can be new or modified/reconstructed

Between the five dimensions, there are 15 model bulk terminals used for the NSPS XXa analysis, 9 used for the MACT R analysis, and 61 used for the GACT 6B analysis. For the purposes of assessing equipment leaks, each model bulk terminal was assumed to have 385 valves, 2,625 flanges and connectors, and 15 pumps.

### 3.2.4 *Activity Data*

The emissions reduction and engineering cost analysis presented in this chapter relies on counts of affected facilities to support the review of NSPS XX and the technology review of MACT R and GACT 6B. Details on these counts are contained in the underlying Technical Memos used to support the reviews.

For NSPS XXa, 5 new and 15 modified or reconstructed bulk terminals are projected over the first 5 years of the action. Given the lack of historical data on facility construction or projection of future facility construction, EPA assumed the projected new and modified/reconstructed facilities will be created uniformly over time and extrapolated the 5-year projection through 2041 (See Table 3-3 below). The next section includes a discussion of the analysis timeframe.

**Table 3-3: NSPS XXa Projected Affected Facilities, 2027-2041**

| Year | New | Modified/Reconstructed |
|---|---|---|
| 2027 | 5 | 15 |
| 2028 | 6 | 18 |
| 2029 | 7 | 21 |
| 2030 | 8 | 24 |
| 2031 | 9 | 27 |
| 2032 | 10 | 30 |
| 2033 | 11 | 33 |
| 2034 | 12 | 36 |
| 2035 | 13 | 39 |
| 2036 | 14 | 42 |
| 2037 | 15 | 45 |
| 2038 | 16 | 48 |
| 2039 | 17 | 51 |
| 2040 | 18 | 54 |
| 2041 | 19 | 57 |

Note: of the 15 modified/reconstructed facilities assumed by 2027, 2 are assumed to be meeting an 80 mg/L loading rack emissions limit, 5 are assumed to be meeting 35 mg/L, and 8 are assumed to be meeting 10 mg/L.

For MACT R and GACT 6B, EPA assumes the count of each affected facilities is constant from 2027-2041. In absence of reliable data on facility closure over time, EPA considered this to be a reasonable assumption given that gasoline consumption is projected to be roughly flat over the projected time horizon, (EIA's AEO 2023 projects gasoline consumption will fall by 0.6 percent per year from 2027 to 2041). For the distribution of high-level model plants across rules, see Table 3-4 below.

**Table 3-4: Model Plant Distribution and Configurations**

| | NSPS XXa | | MACT R | | GACT 6B | |
|---|---|---|---|---|---|---|
| Facility Type | Count[31] | Configurations | Count | Configurations | Count | Configurations |
| Bulk Terminal | 20 | 15 | 195 | 9 | 1,090 | 61 |
| Bulk Plant | - | - | - | - | 5,913 | 3 |
| Pumping Station | - | - | - | - | 1,800 | 1 |
| Breakout Station | - | - | 15 | 6 | 460 | 6 |

Throughout this chapter, various results will be presented by year for NSPS XXa but not MACT R or GACT 6B; this is because the projection of affected facilities is only changing for NSPS XXa since this is a new source standard.

As discussed in Section 3.2.3.6, a portion of bulk plants are assumed to either already use a vapor balancing system of some kind or to be exempt from any vapor balancing requirement due to not meeting a throughput threshold of 4,000 gallons per day. The distribution of model bulk plants used for the cost and emissions analysis in this RIA is contained in Table 3-5.

**Table 3-5: Assumed Distribution of Controls at Bulk Plants**

| Current Control | Number of Facilities |
|---|---|
| Vapor Balancing for Deliveries and Loading | 1,715 |
| Vapor Balancing for Deliveries or Loading | 270 |
| Requires Vapor Balancing | 2,095 |
| Exempt Based on Low Throughput | 1,833 |

### 3.2.5 *Baseline*

As mentioned in Chapter 1, the impacts of regulatory actions are evaluated relative to a baseline that represents the world without the regulatory action. In this RIA, we present results for the final amendments to NESHAP GACT 6B and MACT R and final NSPS XXa. Throughout this document, we focus the analysis on the requirements that result in quantifiable compliance cost or emissions changes compared to the baseline. For each rule and most

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[31] This count reflects 5 new and 15 modified/reconstructed terminals 5 years following promulgation.

emissions sources, EPA assumed each facility achieved emissions control meeting current standards, and estimated emissions and cost relative to this baseline. An exception is that loading racks are assumed to use submerged fill methods in the baseline even when not explicitly required under current NESHAP or NSPS standards. This is discussed in Section 3.2.2.1. Further, as discussed in Section 3.2.3.6, requirements in some states control emissions from loading racks at bulk plants. Based on a review of state requirements applying to bulk plants, EPA estimated the proportion of these facilities that already employ vapor-balancing systems either for dispensing gasoline, receiving gasoline, or both. Table 3-5 in Section 3.2.4 shows the distribution of vapor-balancing systems at bulk plants used in the analysis. Finally, with respect to cargo tank vapor-tightness standards, the California Air Resource Board (CARB) currently requires cargo tanks be certified to the vapor-tightness standard finalized by this action. Due to data limitations, EPA was not able to account for the impact of the CARB cargo tank requirements in the baseline. EPA is not aware of any other state standards that are more strict than current federal standards.

For the analysis, we calculate the cost and emissions impacts of the NSPS and NESHAP amendments from 2027 to 2041. The initial analysis year is 2027 as we assume the final action may be signed in late 2023 or early 2024. We assume full compliance with the amendments to MACT R and GACT 6B will take effect three years later in 2027, which is consistent with the requirements in Section 112 of the Clean Air Act for HAP standards. One exception to this is that the requirements for EFR tanks under MACT R and GACT 6B require fitting controls, which will require degassing of the storage vessel. These controls must be installed at the first degassing of the storage vessel after three years from the promulgation date of the final action, but in case more than 10 years from the promulgation date of the final action. Facilities will have 3 years to identify storage vessels that need to be upgraded and identify appropriate fitting control systems that need to be installed. Facilities are allowed up to 10 years in order to align the installation of the controls with a planned degassing event, to the extent practicable, to minimize the offsetting emissions that occur due to a degassing event solely to install the fitting controls. To the extent that that not all storage vessels have fitting controls installed in the first 10 years of the analysis period, cost and emissions impacts will be overestimated during that span. The final analysis year is 2041, which allows us to provide fifteen years of impacts after the amendments are assumed to fully take effect.  A fifteen-year timespan was selected to cover the lifetime of the longest-lived capital equipment (upgraded storage tanks and VRU/VCU for loading racks) expected to be installed as a result of the amendments. We assume the NSPS XXa amendments take effect immediately upon proposal (2022), which is consistent with compliance requirements for NSPS under Section 111 of the Clean Air Act. It is appropriate to set the initial analysis year as 2027 rather than 2022 given that the impacts of NSPS XXa are much smaller than those for GACT 6B and MACT R.

### 3.2.6 *Product Recovery*

Engineering cost estimates in this chapter include projections of revenue from product recovery. This is because control options analyzed in this RIA lead to the recovery of gasoline vapor. Recovered gasoline vapor is monetized as product recovery credits by multiplying VOC emissions reductions by a VOC credit of 662$/ton. The VOC recovery credit was calculated based on the average refiner’s wholesale spot price for all gasoline types in 2021 ($2.07/gallon).[32] Using a density of gasoline of 6.25 lb/gallon yields the assumed VOC credit ((2.07 ($/gallon) / 6.25 (lb/gallon)) × 2000 (lb/ton) = 662 ($/ton)) (See the Technical Memo on Equipment Leaks (RTI, 2023), footnote 3). The estimated value of gasoline recovered is similar to the average bulk price of gasoline in 2021 of $2.09. (See Table 2-13). Throughout this document, we treat the revenues associated with gasoline vapor recovery as an offset to projected compliance cost. We consider this the appropriate choice because the product recovery accrues directly to firms rather than society. These revenues may also be considered as a benefit of the regulatory action. However, regardless of whether this revenue is considered a compliance cost offset or benefit, the associated net benefits are equivalent.

Because the controls considered lead to product recovery, it is possible for the cost of a control option to be negative once the value of product recovery is considered (the potential annualized costs may be outweighed by the revenue from product recovery). This observation may typically support an assumption that owners of gasoline distribution facilities would continue to perform the emissions abatement activity regardless of whether a requirement is in place, because it is in their private self-interest. However, there may be an opportunity cost associated with the installation of environmental controls or implementation of compliance

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[32] EIA, 2023. <https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=EMA_EPM0_PBR_NUS_DPG&f=M>.

activities (for purposes of mitigating the emission of pollutants) that is not reflected in the control costs. If environmental investment displaces investment in productive capital, the difference between the rate of return on the marginal investment displaced by the mandatory environmental investment is a measure of the opportunity cost of the environmental requirement to the regulated entity. To the extent that any opportunity costs are not added to the control costs, the compliance costs presented above may be underestimated. In addition, the hurdle rate is defined as the minimum rate of return on an investment that a firm would deem acceptable under typical business practices. Thus, if the hurdle rate is higher on average for firms in this industry than the interest rate used in estimating the compliance costs (7.75% at the time of this analysis), then these investments in environmental controls may potentially not necessarily be undertaken on average.

From a social perspective, however, the increased financial returns from gasoline recovery accrue to entities somewhere along the gasoline distribution supply chain and should be accounted for in a national-level analysis. An economic argument can be made that, in the long run, no single entity bears the entire burden of compliance costs or fully appropriates the financial gain of the additional revenues associated with gasoline recovery. The change in economic surplus resulting from gasoline recovery is likely to be spread across different market participants. The simplest and most transparent approach for allocating these revenues would be to assign the compliance costs and revenues to a model plant and not make assumptions regarding the allocation of costs and revenues across agents. We follow this approach for allocating these revenues in the cost analysis for this final action.

### 3.3 Description of Regulatory Options

This RIA analyzes less and more stringent alternative regulatory options in addition to the analyzing the amendments finalized for GACT 6B, MACT R, and NSPS XXa. This section details the regulatory options examined for each rule. In addition to the control options discussed in each section, EPA is also finalizing revisions related to emissions during periods of startup, shutdown, and malfunction (SSM); additional requirements for electronic reporting of performance test results, performance evaluation reports, and compliance reports; monitoring and operating requirements for control devices; and other minor technical improvements.

### 3.3.1 *GACT 6B*

GACT 6B regulates emissions from loading racks at bulk terminals and bulk plants, storage tanks at bulk terminals, bulk plants, and pipeline breakout stations, cargo tank vapor-tightness, and equipment leaks at bulk terminals, bulk plants, pipeline breakout stations, and pipeline pumping stations. Under the current standards, emissions from loading racks at large bulk gasoline terminals (those with gasoline throughput of 250,000 gallons per day or greater) are controlled by vapor collection and processing systems meeting 80 mg/L and the cargo tanks being loaded must be certified to be vapor tight. Small bulk gasoline terminals and bulk gasoline plants must use submerged filling when loading gasoline. Emissions from storage vessels with a design capacity greater than or equal to 75 $m^3$ are controlled by equipment requirements. Equipment leaks are repaired upon detection using AVO methods.

Based on the technology review, EPA is revising requirements for the following:

- Loading operations: large bulk terminals must control emissions using a vapor collection and processing system meeting 35 mg/L. Bulk plants must install vapor-balancing systems. Cargo tanks must be certified to be vapor-tight to a standard of 0.5" – 1.25" water pressure loss (see Table 3-2).
- Storage Tanks: EFR tanks must have fitting controls compliant with NSPS Kb and LEL monitoring must be conducted for IFR tanks.[33]
- Equipment Leaks: equipment leaks on all equipment in gasoline service at bulk terminals, bulk plants, pipeline breakout stations, and pipeline pumping stations must be monitored annually using EPA Method 21 or OGI.

Bulk plants that do not meet a minimum throughput threshold of 4,000 gallons per day are exempt from the vapor balancing requirement. The current and final standards for GACT 6B are summarized in Table 3-6 below.

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[33] For a description of the compliance timeline for fitting controls on EFR tanks, see Section 3.2.5.

**Table 3-6: Current and Final Standards for NESHAP GACT 6B**

| Emissions Source | Facility | Current Standard | Final Standard |
|---|---|---|---|
| Loading Racks | Small Bulk Terminal (<250,000 gpd, >20,000 gpd) | Submerged fill | Submerged fill |
| | Large Bulk Terminal (>250,000 gpd) | 80 mg/L | 35 mg/L |
| | Bulk Plant (< 20,000 gpd) | Submerged fill | Require vapor balancing system |
| Storage Tanks | Regular Tanks | Compliance with NSPS Kb except for secondary seal on IFR tanks and some fittings controls | Require NSPS Kb fitting controls for EFR Tanks and LEL monitoring for IFR Tanks |
| | Surge Control Tanks | Require fixed roof tanks | Require fixed roof tanks |
| Equipment Leaks | Bulk Terminals, Bulk Plants, Pipeline Breakout Stations, Pipeline Pumping Stations | Monthly AVO inspections | Annual instrument monitoring |
| Cargo Tank Vapor-tightness | Bulk Terminals and Bulk Plants | Maximum allowable pressure loss during certification of 3” water column (WC) | Maximum allowable pressure loss during certification of 0.5” – 1.25” WC |

We also analyze less and more stringent alternative regulatory options as compared to our final option with all options being more stringent than the current GACT 6B, for this rule in adherence to OMB Circular A-4. For GACT 6B, less stringent regulatory options include maintaining control requirements for large storage tanks at their current level, increasing vapor-tightness standards on cargo tanks to 1” – 2.5” water pressure loss (the current MACT standards), and not requiring vapor-balancing systems on loading racks at bulk plants. More stringent regulatory options include increasing equipment leak monitoring frequency from annual to quarterly, requiring IFR tanks to meet NSPS Kb standards, and strengthening the vapor-tightness requirement for cargo tanks. The final, less stringent, and more stringent regulatory options for GACT 6B are summarized in Table 3-7 below.

**Table 3-7: Regulatory Options Examined in this RIA – GACT 6B**

| | | | Regulatory Option | | |
|---|---|---|---|---|---|
| **Facility** | **Emissions Source** | **Requirement** | **Less Stringent** | **Final** | **More Stringent** |
| Bulk Terminals, Pipeline Breakout Stations, Bulk Plants, and Pipeline Pumping Stations | Equipment Leaks | Annual Instrument Monitoring | X | X | |
| | | Quarterly Instrument Monitoring | | | X |
| | Misc. | MRR | X | X | X |
| Bulk Terminals, Pipeline Breakout Stations, and Bulk Plants | Large Storage Tanks | No change | X | | |
| | | EFR tank to Kb and LEL Monitoring for IFR tank | | X | |
| | | EFR tank/IFR tank to Kb and LEL Monitoring for IFRT | | | X |
| Bulk Terminals and Bulk Plants | Cargo Tank Vapor-tightness | MACT[34] | X | | |
| | | State Requirement | | X | |
| | | Beyond State Requirement | | | X |
| Small Bulk Terminals | Loading Racks | No change | X | X | X |
| Large Bulk Terminals | Loading Racks | 35 mg/L | X | X | |
| | | 10 mg/L | | | X |
| Bulk Plants | Loading Racks | No change | X | | |
| | | Vapor-balancing | | X | X |

### 3.3.2 *MACT R*

MACT R regulates emissions from loading racks and cargo tank vapor-tightness at bulk gasoline terminals, and storage tanks and equipment leaks at bulk terminals and pipeline

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[34] With respect to cargo-tank vapor-tightness requirements, “NSPS/GACT” refers to a maximum allowable pressure loss during certification based on current NSPS XX/GACT 6B, “MACT” refers to a maximum allowable pressure loss during certification based on MACT R limits, “State Requirement” refers to a maximum allowable pressure loss during certification based on the California Air Resource Board (CARB) standard, and “Beyond State Requirement” refers to a stricter standard beyond the CARB standard. For more details, refer to the Technical Memo on Loading Rack Control Options.

breakout stations. Under the current standards, emissions from loading racks at bulk gasoline terminals are controlled by vapor collection and processing systems meeting 10 mg/L and the cargo tanks being loaded must be certified to be vapor tight. Emissions from storage vessels with a design capacity greater than or equal to 75 $m^3$ at bulk gasoline terminals and pipeline breakout stations are controlled by equipment requirements. Equipment leaks at bulk gasoline terminals and pipeline breakout stations are repaired upon detection using AVO methods.

Based on the technology review, EPA is revising requirements for the following:

- Storage Tanks: EFR tanks must have fitting controls compliant with NSPS Kb and LEL monitoring must be conducted for IFR tanks.[35]
- Equipment Leaks: equipment leaks on all equipment in gasoline service at bulk gasoline terminals and pipeline breakout stations must be monitored semiannually using EPA Method 21 or OGI.
- Cargo tanks must be certified to be vapor-tight to a standard of 0.5” – 1.25” water pressure loss (see Table 3-2).

EPA is also finalizing that MACT R explicitly require the use of submerged fill during loading operations. Because submerged loading is assumed to take place in the baseline (see Section 3.2.2.1), this requirement is not expected to have direct cost or emissions implications. The current and final standards for MACT R are summarized in Table 3-8 below.

**Table 3-8: Current and Final Standards for MACT R**

| Emissions Source | Facility | Current Standard | Final Standard |
|---|---|---|---|
| Loading Racks | Bulk Terminal | 10 mg/L | No change (10 mg/L) |
| Storage Tanks | Bulk Terminals and Pipeline Breakout Stations | Compliance with NSPS Kb except for some fitting controls | Require NSPS Kb fitting controls for EFR Tanks and LEL monitoring for IFR Tanks |
| Equipment Leaks | Bulk Terminals and Pipeline Breakout Stations | Monthly AVO inspections | Semiannual instrument monitoring |
| Cargo Tank Vapor-tightness | Bulk Terminals | Maximum allowable pressure loss during certification of 1” – 2.5” WC | Maximum allowable pressure loss during certification of 0.5” – 1.25” WC |

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[35] For a description of the compliance timeline for fitting controls on EFR tanks, see Section 3.2.5.

We also analyze less and more stringent alternative regulatory options as compared to our final option with all options being more stringent that the current MACT R, for this rule in adherence to the current guidance in OMB Circular A-4. For MACT R, less stringent regulatory options include maintaining control requirements for storage tanks at their current level, maintaining vapor-tightness standards on cargo tanks to 1” – 2.5” water pressure loss, and implementing equipment leak monitoring annually rather than semiannually. More stringent regulatory options include requiring IFR tanks to meet NSPS Kb standards and strengthening the vapor-tightness requirement for cargo tanks. The final, less stringent than final, and more stringent regulatory options for MACT R are summarized in Table 3-9 below.

**Table 3-9: Regulatory Options Examined in this RIA – MACT R**

| | | | **Regulatory Option** | | |
|---|---|---|---|---|---|
| **Facility** | **Emissions Source** | **Requirement** | **Less Stringent** | **Final** | **More Stringent** |
| Bulk Terminals and Pipeline Breakout Stations | Equipment Leaks | Annual Instrument Monitoring | X | | |
| | | Semiannual Instrument Monitoring | | X | |
| | | Quarterly Instrument Monitoring | | | X |
| | Storage Tanks | No change | X | | |
| | | EFR tank to Kb and LEL Monitoring for IFR tank | | X | |
| | | EFR tank/IFR tank to Kb and LEL Monitoring for IFRT | | | X |
| | Misc. | MRR | X | X | X |
| Bulk Terminals | Loading Racks | 10 mg/L | X | X | X |
| | Cargo Tank Vapor-tightness | MACT | X | | |
| | | State Requirement | | X | |
| | | Beyond State Requirement | | | X |

### 3.3.3 *NSPS XXa*

NSPS XXa would regulate emissions from loading racks at bulk gasoline distribution terminals constructed or modified after date of publication of the proposal of this action (June 10, 2022). Emissions from loading racks at bulk gasoline terminals are currently controlled by vapor collection and processing systems meeting 35 mg/L and the cargo tanks being loaded must be certified to be vapor tight.[36] Equipment leaks are repaired upon detection using AVO methods. Based on the NSPS review, EPA is finalizing requirements for the following:

- Loading operations: new bulk terminals must control emissions using a vapor collection and processing system meeting 1 mg/L. Reconstructed/modified bulk terminals must control emissions using a vapor collection and processing system meeting 10 mg/L. Cargo tanks must be certified to be vapor-tight to a standard of 0.5" – 1.25" water pressure loss (see Table 3-2).
- Equipment Leaks: equipment leaks on all equipment in gasoline service at bulk gasoline terminals must be monitored quarterly using EPA Method 21 or OGI.

The current and final standards for NSPS XX and NSPS XXa, respectively, are summarized in Table 3-10 below.

**Table 3-10: Current and Final Standards for NSPS XX and NSPS XXa**

| Emissions Source | Facility | Current Standard | Final Standard |
|---|---|---|---|
| Loading Racks | Bulk Terminal – New | 35 mg/L | 1 mg/L |
| | Bulk Terminal – Modified/Reconstructed | 35 mg/L | 10 mg/L |
| Equipment Leaks | Bulk Terminal | Monthly AVO inspections | Quarterly instrument monitoring |
| Cargo Tank Vapor-tightness | Bulk Terminal | Maximum allowable pressure loss during certification of 3" water column (WC) | Maximum allowable pressure loss during certification of 0.5" – 1.25" WC |

We analyze less and more stringent alternative regulatory options as compared to our final option, but all options being more stringent that the current standard, for this rule in adherence to the guidance in the current OMB Circular A-4. For NSPS XXa, less stringent regulatory options increasing vapor-tightness standards on cargo tanks to 1" – 2.5" water pressure loss (the current MACT standards) and implementing equipment leak monitoring annually rather than quarterly. The more stringent regulatory option includes strengthening the

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[36] Allowance is provided to meet 80 mg/L for affected facilities with an "existing vapor processing system."

vapor-tightness requirement for cargo tanks. The final, less stringent than final, and more stringent than final regulatory options for NSPS XXa are summarized in Table 3-11 below.

**Table 3-11: Regulatory Options Examined in this RIA – NSPS XXa**

| Facility | Emissions Source | Requirement | Regulatory Option: Less Stringent | Regulatory Option: Final | Regulatory Option: More Stringent |
|---|---|---|---|---|---|
| Bulk Terminal | Equipment Leaks | Annual Instrument Monitoring | X | | |
| | | Quarterly Instrument Monitoring | | X | X |
| | Loading Racks | New – 35 mg/L, modified – 35 mg/L | X | | |
| | | New – 1 mg/L, modified – 10 mg/L | | X | X |
| | Cargo Tank Vapor-tightness | MACT | X | | |
| | | State Requirement | | X | |
| | | Beyond State Requirement | | | X |
| | Misc. | MRR | X | X | X |

## 3.4 Emissions Reduction Analysis

### 3.4.1 *Baseline VOC/HAP Emissions Estimates*

The baseline emissions for VOC and HAP (tons per year) are contained in Table 3-12 below. Recall from Section 3.2.4 that the projected count of affected facilities for MACT R and GACT 6B is constant from 2027-2041, while projected facility counts for NSPS XXa are projected to vary over time. Baseline emissions are thus constant for MACT R and GACT 6B but variable for NSPS XXa. The figures for NSPS XXa in Table 3-12 reflect baseline emissions in 2027, 5 years following the promulgation of the rule. This caveat applies to all per-year figures presented for NSPS XXa for the remainder of the chapter. Baseline emissions for NSPS XXa from 2027-2041 are in Table 3-13.

**Table 3-12: Baseline Emissions in 2027 (Short Tons)**

| Rule | VOC Baseline Emissions | HAP Baseline Emissions |
|---|---|---|
| NSPS XXa | 3,900 | 160 |
| MACT R | 18,000 | 850 |
| GACT 6B | 99,000 | 5,300 |
| All | 120,000 | 6,300 |

Note: Numbers rounded to two significant digits unless otherwise noted.

**Table 3-13: NSPS XXa Baseline Emissions (Tons), 2027-2041**

| Year | VOC Baseline Emissions | HAP Baseline Emissions |
|---|---|---|
| 2027 | 3,900 | 160 |
| 2028 | 4,700 | 190 |
| 2029 | 5,400 | 220 |
| 2030 | 6,200 | 250 |
| 2031 | 7,000 | 280 |
| 2032 | 7,800 | 310 |
| 2033 | 8,600 | 340 |
| 2034 | 9,300 | 370 |
| 2035 | 10,000 | 400 |
| 2036 | 11,000 | 440 |
| 2037 | 12,000 | 470 |
| 2038 | 12,000 | 500 |
| 2039 | 13,000 | 530 |
| 2040 | 14,000 | 560 |
| 2041 | 15,000 | 590 |

Note: Numbers rounded to two significant digits unless otherwise noted.

### 3.4.2 *Projected VOC/HAP Emissions Reduction*

Projected emissions reductions for each rule and option package are presented in Table 3-14 below. Reductions for every year from 2027-2041 are presented for NSPS XXa in Table 3-15. Roughly 89 percent of the VOC emissions reductions and 91 percent of the HAP emissions reductions projected under the final options are due to the revisions affecting GACT 6B. The same is broadly true for the less stringent (92 percent and 94 percent) and more stringent (89 percent and 90 percent) alternative regulatory options. Further, the bulk of the VOC/HAP emissions reductions projected under GACT 6B are coming from the requirement that bulk plants install a vapor-balancing system to control emissions from loading operations (24,000 tons of projected VOC reductions per year, 950 tons of projected HAP reductions per year). For a discussion of emissions reduction by emissions point for each rule and option package, see Section 3.5.1 below.

**Table 3-14: Emissions Reductions for Regulatory Options, Tons per Year[a,b,c]**

| Rule | Option Package | VOC | HAP |
|---|---|---|---|
| NSPS XXa | Less Stringent | 240 | 12 |
|  | Final | 2,900 | 120 |
|  | More Stringent | 3,000 | 120 |
| MACT R | Less Stringent | 0 | 0 |
|  | Final | 2,200 | 130 |
|  | More Stringent | 2,700 | 170 |
| GACT 6B | Less Stringent | 11,000 | 890 |
|  | Final | 40,000 | 2,100 |
|  | More Stringent | 50,000 | 2,700 |
| All Rules | Less Stringent | 12,000 | 950 |
|  | Final | 45,000 | 2,300 |
|  | More Stringent | 56,000 | 3,000 |

[a] Numbers rounded to two significant digits unless otherwise noted.
[b] NSPS XXa reductions reflect those occurring in 2027. For each year 2027-2041, see Table 3-15 below.
[c] The options whose emission reductions are included in this table for each rule are those described in Tables 3-7, 3-9, and 3-11.

**Table 3-15: Emissions Reductions for Regulatory Options (Tons), NSPS XXa, 2027-2041**

|  | Less Stringent |  | Final |  | More Stringent |  |
|---|---|---|---|---|---|---|
| Year | VOC | HAP | VOC | HAP | VOC | HAP |
| 2027 | 240 | 12 | 2,900 | 120 | 3,000 | 120 |
| 2028 | 290 | 14 | 3,500 | 150 | 3,600 | 150 |
| 2029 | 340 | 17 | 4,100 | 170 | 4,100 | 170 |
| 2030 | 390 | 19 | 4,700 | 190 | 4,700 | 200 |
| 2031 | 440 | 22 | 5,300 | 220 | 5,300 | 220 |
| 2032 | 490 | 24 | 5,900 | 240 | 5,900 | 240 |
| 2033 | 540 | 26 | 6,500 | 270 | 6,500 | 270 |
| 2034 | 590 | 29 | 7,100 | 290 | 7,100 | 290 |
| 2035 | 640 | 31 | 7,700 | 320 | 7,700 | 320 |
| 2036 | 680 | 34 | 8,200 | 340 | 8,300 | 340 |
| 2037 | 730 | 36 | 8,800 | 370 | 8,900 | 370 |
| 2038 | 780 | 38 | 9,400 | 390 | 9,500 | 390 |
| 2039 | 830 | 41 | 10,000 | 410 | 10,000 | 420 |
| 2040 | 880 | 43 | 11,000 | 440 | 11,000 | 440 |
| 2041 | 930 | 46 | 11,000 | 460 | 11,000 | 470 |

Note: Totals may not sum due to independent rounding. Numbers rounded to two significant digits unless otherwise noted.

### 3.4.3 *Projected Secondary Emissions Increases*

With the additional operation of control devices associated with the final action, $CO_2$, $NO_x$, $SO_2$, and CO emissions will be generated as a result of the additional electricity and natural gas usage required to operate them. All secondary emissions impacts are associated with the usage of vapor combustion and recovery units on loading racks at bulk gasoline terminals.

Because no amendments are being finalized for loading racks at major source bulk terminals in either the final, less stringent, or more stringent alternative options, no secondary emissions increases are projected for MACT R. This section characterizes the projected increases of $CO_2$, $NO_x$, $SO_2$, and CO caused by the action.

Table 3-16 and Table 3-17 contain the projected secondary emissions increases associated with the final, less stringent, and more stringent options for GACT 6B and NSPS XXa across the analytical timeframe for the final action. The more stringent alternative options for GACT 6B contain stricter emissions limits for loading racks at large bulk terminals, causing slight increases in projected secondary impacts. The final, less stringent, and more stringent alternative options for NSPS contain the same standards for loading racks, so secondary impacts are the same across the three option packages.

**Table 3-16: GACT 6B Secondary Emissions Increases (short tons)**

| | Final/Less Stringent Options | | | | More Stringent Options | | | |
|---|---|---|---|---|---|---|---|---|
| | $CO_2$ | $NO_2$ | $SO_2$ | CO | $CO_2$ | $NO_2$ | $SO_2$ | CO |
| Per-Year | 32,000 | 19 | 0.05 | 86 | 32,000 | 19 | 0.10 | 86 |
| 2027-2041 | 490,000 | 280 | 0.67 | 1,300 | 490,000 | 280 | 1.5 | 1,300 |

Note: Totals may not sum due to independent rounding. Numbers rounded to two significant digits unless otherwise noted.

**Table 3-17: NSPS XXa Secondary Emissions Increases, Final/Less Stringent/More Stringent Options (Tons)**

| Year | $CO_2$ | $NO_2$ | $SO_2$ | CO |
|---|---|---|---|---|
| 2027 | 2,100 | 1.3 | 1.3 | 0 |
| 2028 | 2,600 | 1.5 | 1.6 | 0 |
| 2029 | 3,000 | 1.8 | 1.9 | 0 |
| 2030 | 3,400 | 2.0 | 2.1 | 0 |
| 2031 | 3,800 | 2.3 | 2.4 | 0 |
| 2032 | 4,300 | 2.5 | 2.7 | 0 |
| 2033 | 4,700 | 2.8 | 2.9 | 0 |
| 2034 | 5,100 | 3.0 | 3.2 | 0 |
| 2035 | 5,600 | 3.3 | 3.5 | 0 |
| 2036 | 6,000 | 3.5 | 3.7 | 0 |
| 2037 | 6,400 | 3.8 | 4.0 | 0 |
| 2038 | 6,800 | 4.0 | 4.3 | 0 |
| 2039 | 7,300 | 4.3 | 4.5 | 0 |
| 2040 | 7,700 | 4.5 | 4.8 | 0 |
| 2041 | 8,100 | 4.8 | 5.1 | 0 |
| Total | 77,000 | 45 | 48 | 0 |

Note: Totals may not sum due to independent rounding. Numbers rounded to two significant digits unless otherwise noted.

## 3.5 Engineering Cost Analysis

### 3.5.1 *Detailed Impacts Tables*

This section presents detailed impacts tables by rule and option package. All tables contain per-year figures other than tables representing NSPS XXa, which contains figures for the representative year 2027 (four years following expected rule promulgation). Total annualized costs include capital cost annualized using the bank prime rate in accord with the guidance of the EPA Air Pollution Control Cost Manual (U.S. EPA, 2017a), operating and maintenance costs, and product recovery (recovered gasoline). To estimate these annualized costs, the EPA uses a conventional and widely accepted approach, called equivalent uniform annual cost (EUAC) that applies a capital recovery factor (CRF) multiplier to capital investments and adds that to the annual incremental operating expenses to estimate annual costs. This cost estimation approach is described in the EPA Air Pollution Control Cost Manual (U.S. EPA, 2017a). These annualized costs are the costs to directly affected firms and facilities (or “private investment”), and thus are not true social costs. Detailed discussion of these costs can be found in the technical memos produced for each rule that can be found in the docket. Gasoline product recovery estimates by emissions point are shown below, and the concept of product recovery is discussed earlier in Section 3.2.6. The bank prime rate was 7.75 percent at the time of the cost analysis. All cost estimates are in 2021$.

#### *3.5.1.1 GACT 6B*

Table 3-18 contains per-year impacts by emissions point for the final amendments to GACT 6B.

**Table 3-18: Final Options, Detailed Impacts by Emissions Point (per year), GACT 6B**

| Emissions Point | Total Annualized Cost without Product Recovery | Product Recovery | Total Annualized Cost with Product Recovery | VOC Reductions | HAP Reductions |
|---|---|---|---|---|---|
| Loading Racks | $10,000,000 | $16,000,000 | -$5,600,000 | 25,000 | 980 |
| Storage Tanks | $1,700,000 | $2,500,000 | -$840,000 | 3,800 | 190 |
| Equipment Leaks | $1,300,000 | $4,800,000 | -$3,500,000 | 7,300 | 730 |
| Cargo Tanks | $1,100,000 | $3,100,000 | -$2,100,000 | 4,700 | 190 |
| MRR | $6,300,000 | $0 | $6,300,000 | 0 | 0 |
| Total | $20,000,000 | $26,000,000 | -$5,700,000 | 40,000 | 2,100 |

Note: Totals may not sum due to independent rounding. Numbers rounded to two significant digits unless otherwise noted. Negative signs denote cost savings (product recovery exceeding compliance costs).

The driver of impacts from these amendments is the vapor balancing requirement for loading racks at bulk plants, which accounts for about 96 percent of the annualized costs associated with loading racks and about 97 percent of the emissions reductions. Loading racks in total account for about 62 percent of the VOC reductions from the final amendments to GACT 6B, with the remainder coming from storage tanks, equipment leaks, and cargo tanks in roughly equal measure. The second largest component of annualized cost is those resulting from the updates to Monitoring, Reporting, and Recordkeeping (MRR). These MRR updates include additional monitoring of flares and thermal combustion units at loading racks, periodic testing of thermal combustion units at loading racks, and annual LEL (lower explosive level) monitoring at storage vessels as described in the monitoring options and costs memo prepared for this final action (RTI, 2023).

Note that annual instrument monitoring for equipment leaks is cost-saving relative to the current requirement of monthly AVO monitoring. This is due to the cost savings realized by reducing monitoring frequency from monthly to annual. This occurs despite instrument monitoring (by either OGI or Method 21) being more costly per monitoring event (and in the case of OGI requiring capital usage). As monitoring frequency increases, instrument monitoring is less likely to be cost-saving relative to current AVO. See the Technical Memo on Equipment Leaks (RTI, 2023) for details of the analysis.

**Table 3-19: Less Stringent Options, Detailed Impacts by Emissions Point (per year), GACT 6B**

| Emissions Point | Total Annualized Cost without Product Recovery | Product Recovery | Total Annualized Cost with Product Recovery | VOC Reductions (tpy) | HAP Reductions (tpy) |
|---|---|---|---|---|---|
| Loading Racks | $440,000 | $90,000 | $350,000 | 820 | 33 |
| Storage Tanks | $0 | $0 | $0 | 0 | 0 |
| Equipment Leaks | $1,300,000 | $4,800,000 | -$3,500,000 | 7,300 | 730 |
| Cargo Tanks | $600,000 | $2,200,000 | -$1,600,000 | 3,300 | 130 |
| MRR | $4,800,000 | $0 | $4,800,000 | 0 | 0 |
| Total | $7,100,000 | $7,100,000 | $20,000 | 11,000 | 890 |

Note: Totals may not sum due to independent rounding. Numbers rounded to two significant digits unless otherwise noted. Negative signs denote cost savings (product recovery exceeding compliance costs, or savings without product recovery). Options described in Table 3-7.

Table 3-19 contains per-year impacts by emissions point for the less stringent alternative options for GACT 6B. The main difference from the final options is removal of the requirement for vapor-balancing systems at bulk plants, which substantially reduces annualized cost and emissions reductions. MRR is by far the largest component of cost for the less stringent alternative option package.

**Table 3-20: More Stringent Options, Detailed Impacts by Emissions Point (per year), GACT 6B**

| Emissions Point | Total Annualized Cost without Product Recovery | Product Recovery | Total Annualized Cost with Product Recovery | VOC Reductions (tpy) | HAP Reductions (tpy) |
|---|---|---|---|---|---|
| Loading Racks | $13,000,000 | $16,000,000 | -$2,900,000 | 27,000 | 1,100 |
| Storage Tanks | $31,000,000 | $5,100,000 | $26,000,000 | 7,700 | 380 |
| Equipment Leaks | $15,000,000 | $7,200,000 | $7,300,000 | 11,000 | 1,100 |
| Cargo Tanks | $1,500,000 | $3,300,000 | -$1,800,000 | 5,000 | 200 |
| MRR | $6,300,000 | $0 | $6,300,000 | 0 | 0 |
| Total | $67,000,000 | $32,000,000 | $35,000,000 | 50,000 | 2,700 |

Note: Totals may not sum due to independent rounding. Numbers rounded to two significant digits unless otherwise noted. Negative signs denote cost savings (product recovery exceeding compliance costs). Options are summarized in Table 3-11.

Table 3-20 contains per-year impacts by emissions point for the more stringent alternative options for GACT 6B. The more stringent alternative options tighten requirements at every emissions point (excluding MRR). The main driver of emissions reductions continues to be the loading rack requirement, which accounts for more than half of emissions reductions. The requirement for IFR tanks to meet NSPS Kb standards results in a major increase in annualized costs with a comparatively small increase in emissions reductions. Tightening standards for IFR tanks is substantially more costly than for EFR tanks because most of the tanks at gasoline distribution facilities are IFR tanks. Further, per-tank emissions reductions are much lower when upgrading an IFR tank to Kb relative to an EFR tank. One result of having IFR tanks meet NSPS Kb standards is that the costs of equipment leak controls exceeds that of the product recovery that would occur as a result of these controls, hence yielding a positive annualized cost as a whole.

### *3.5.1.2 MACT R*

Table 3-21 contains per-year impacts by emissions point for the final amendments to MACT R, which tighten requirements for storage tanks, equipment leak monitoring, cargo tank vapor-tightness, and MRR.

**Table 3-21: Final Options, Detailed Impacts by Emissions Point (per year), MACT R**

| Emissions Point | Total Annualized Cost without Product Recovery | Product Recovery | Total Annualized Cost with Product Recovery | VOC Reductions (tpy) | HAP Reductions (tpy) |
|---|---|---|---|---|---|
| Loading Racks | $0 | $0 | $0 | 0 | 0 |
| Storage Tanks | $310,000 | $420,000 | -$100,000 | 630 | 31 |
| Equipment Leaks | $150,000 | $450,000 | -$300,000 | 690 | 69 |
| Cargo Tanks | $640,000 | $560,000 | $82,000 | 850 | 34 |
| MRR | $2,200,000 | $0 | $2,200,000 | 0 | 0 |
| Total | $3,300,000 | $1,400,000 | $1,900,000 | 2,200 | 130 |

Note: Totals may not sum due to independent rounding. Numbers rounded to two significant digits unless otherwise noted. Negative signs denote cost savings (product recovery exceeding compliance costs, or savings in costs without product recovery).

The majority of the annualized costs come from increased MRR requirements, and emissions reductions are small compared to those for GACT 6B due to the smaller number of major source facilities. Note that, as with GACT 6B, OGI monitoring for equipment leaks is projected to be cost-saving relative to the current monthly AVO inspection requirement due to cost savings from reduced monitoring frequency (semiannual vs monthly).

**Table 3-22: Less Stringent Options, Detailed Impacts by Emissions Point (per year), MACT R**

| Emissions Point | Total Annualized Cost without Product Recovery | Product Recovery | Total Annualized Cost with Product Recovery | VOC Reductions (tpy) | HAP Reductions (tpy) |
|---|---|---|---|---|---|
| Loading Racks | $0 | $0 | $0 | 0 | 0 |
| Storage Tanks | $0 | $0 | $0 | 0 | 0 |
| Equipment Leaks | -$150,000 | $300,000 | -$450,000 | 460 | 46 |
| Cargo Tanks | $360,000 | $0 | $360,000 | 0 | 0 |
| MRR | $2,200,000 | $0 | $2,200,000 | 0 | 0 |
| Total | $2,500,000 | $300,000 | $2,100,000 | 460 | 46 |

Note: Totals may not sum due to independent rounding. Numbers rounded to two significant digits unless otherwise noted. Negative signs denote cost savings (product recovery exceeding compliance costs, or savings in costs without product recovery).

Table 3-22 contains per-year impacts by emissions point for the less stringent alternative options for MACT R. The less stringent set of alternative options maintains storage tank and cargo tank vapor tightness requirements at their current level and reduces the frequency of equipment leak monitoring from semiannual to annual. All emissions reductions come from LDAR, and the bulk of the costs once again come from increased MRR.

**Table 3-23: More Stringent Options, Detailed Impacts by Emissions Point (per year), MACT R**

| Emissions Point | Total Annualized Cost without Product Recovery | Product Recovery | Total Annualized Cost with Product Recovery | VOC Reductions (tpy) | HAP Reductions (tpy) |
|---|---|---|---|---|---|
| Loading Racks | $0 | $0 | $0 | 0 | 0 |
| Storage Tanks | $6,700,000 | $560,000 | $6,100,000 | 850 | 42 |
| Equipment Leaks | $690,000 | $540,000 | $150,000 | 820 | 82 |
| Cargo Tanks | $940,000 | $680,000 | $270,000 | 1,000 | 41 |
| MRR | $2,200,000 | $0 | $2,200,000 | 0 | 0 |
| Total | $11,000,000 | $1,800,000 | $8,700,000 | 2,700 | 170 |

Note: Totals may not sum due to independent rounding. Numbers rounded to two significant digits unless otherwise noted.

Table 3-23 contains per-year impacts by emissions point for the more stringent alternative options for MACT R. As with the more stringent alternative options for GACT 6B, the requirement for IFR tanks to meet NSPS Kb standards increases costs dramatically while only marginally reducing emissions. Increased equipment leak monitoring frequency and stricter vapor-tightness requirements for cargo tanks lead to small increases in cost and emission reductions.

#### *3.5.1.3 NSPS XXa*

Table 3-24 contains impacts by emissions point for the final NSPS XXa in 2027, assuming 5 new and 15 modified/reconstructed facilities 5 years following promulgation.

**Table 3-24: Final Options, Detailed Impacts by Emissions Point (2027), NSPS XXa**

| Emissions Point | Total Annualized Cost without Product Recovery | Product Recovery | Total Annualized Cost with Product Recovery | VOC Reductions (tpy) | HAP Reductions (tpy) |
|---|---|---|---|---|---|
| Loading Racks | $1,700,000 | $1,700,000 | -$48,000 | 2,600 | 100 |
| Equipment Leaks | $58,000 | $43,000 | $15,000 | 65 | 7 |
| Cargo Tanks | $66,000 | $200,000 | -$130,000 | 290 | 12 |
| MRR | $230,000 | $0 | $230,000 | 0 | 0 |
| Total | $2,000,000 | $1,900,000 | $66,000 | 2,900 | 120 |

Note: Totals may not sum due to independent rounding. Numbers rounded to two significant digits unless otherwise noted. Negative signs denote cost savings (product recovery exceeding compliance costs, or savings in costs without product recovery).

The majority of annualized cost and emissions reductions result from tight emissions limits on loading racks. Both costs and emissions overall are relatively small for the final NSPS XXa.

**Table 3-25: Less Stringent Options, Detailed Impacts by Emissions Point (2027), NSPS XXa**

| Emissions Point | Total Annualized Cost without Product Recovery | Product Recovery | Total Annualized Cost with Product Recovery | VOC Reductions (tpy) | HAP Reductions (tpy) |
|---|---|---|---|---|---|
| Loading Racks | $0 | $0 | $0 | 0 | 0 |
| Equipment Leaks | -$15,000 | $24,000 | -$39,000 | 37 | 4 |
| Cargo Tanks | $37,000 | $140,000 | -$100,000 | 210 | 8 |
| MRR | $230,000 | $0 | $230,000 | 0 | 0 |
| Total | $250,000 | $160,000 | $89,000 | 240 | 12 |

Note: Totals may not sum due to independent rounding. Numbers rounded to two significant digits unless otherwise noted. Negative signs denote cost savings (product recovery exceeding compliance costs, or savings in costs without product recovery).

Table 3-25 contains impacts by emissions point for the less stringent alternative options for NSPS XXa in 2027, assuming 5 new and 15 modified/reconstructed facilities 5 years following promulgation. The less stringent alternative options for NSPS XXa maintain loading emissions at their current level, and thus eliminated most of the cost and emissions reductions. Equipment leak monitoring frequency is reduced, and cargo tank vapor-tightness requirements are also loosened relative to the final options, marginally impacting cost and emissions reductions.

**Table 3-26: More Stringent Options, Detailed Impacts by Emissions Point (2027), NSPS XXa**

| Emissions Point | Total Annualized Cost without Product Recovery | Product Recovery | Total Annualized Cost with Product Recovery | VOC Reductions | HAP Reductions |
|---|---|---|---|---|---|
| Loading Racks | $1,700,000 | $1,700,000 | -$48,000 | 2,600 | 100 |
| Equipment Leaks | $58,000 | $43,000 | $15,000 | 65 | 7 |
| Cargo Tanks | $97,000 | $210,000 | -$110,000 | 310 | 13 |
| MRR | $230,000 | $0 | $230,000 | 0 | 0 |
| Total | $2,000,000 | $2,000,000 | $85,000 | 3,000 | 120 |

Note: Totals may not sum due to independent rounding. Numbers rounded to two significant digits unless otherwise noted. Negative signs denote cost savings (product recovery exceeding compliance costs, or savings in costs without product recovery).

Table 3-26 contains impacts by emissions point for the more stringent alternative options for NSPS XXa in 2027, assuming 5 new and 15 modified/reconstructed facilities 5 years following promulgation. The more stringent alternative differs from the final options only by adopting a stricter cargo tank vapor-tightness requirement, and cost and emissions are virtually identical under the two options.

### 3.5.2 *Summary Cost Tables*

Estimates of costs per year for each rule and regulatory option are presented below in Table 3-27. The “Capital Cost” column reflects the per-year capital cost for a rule/regulatory option assuming that the cost for each piece of capital is distributed evenly over the life of the equipment applied in the cost estimate for that option. The even distribution of capital cost is an outcome of the Equivalent Uniform Annual Cost (EUAC) method that, as mentioned earlier in this RIA, is a cost methodology employed to estimate the compliance costs for this final rulemaking.  The “Total Capital Investment” column assumes that all capital required for compliance with a rule/regulatory option is purchased in a single year. Total annualized costs are reported both with and without revenue from product recovery included. See Section 3.2.6 for a discussion of product recovery.

## Table 3-27: Estimated Annual Costs for Regulatory Options ($2021)

| Rule | Option Package | Total Capital Investment | Annualized Capital Cost | Operation and Maintenance | Total Annualized Cost w/o Revenue | Revenue from Product Recovery | Total Annualized Cost w/ Revenue |
|---|---|---|---|---|---|---|---|
| NSPS XXa | Less Stringent | $20,000 | $4,000 | $250,000 | $250,000 | $160,000 | $89,000 |
| | Final | $7,200,000 | $480,000 | $1,200,000 | $2,000,000 | $1,900,000 | $66,000 |
| | More Stringent | $7,200,000 | $480,000 | $1,200,000 | $2,000,000 | $2,000,000 | $85,000 |
| MACT R | Less Stringent | $220,000 | $44,000 | $2,400,000 | $2,500,000 | $300,000 | $2,100,000 |
| | Final | $2,400,000 | $190,000 | $3,000,000 | $3,300,000 | $1,400,000 | $1,900,000 |
| | More Stringent | $53,000,000 | $3,600,000 | $3,900,000 | $11,000,000 | $1,800,000 | $8,700,000 |
| GACT 6B | Less Stringent | $5,800,000 | $1,200,000 | $5,700,000 | $7,100,000 | $7,100,000 | $20,000 |
| | Final | $66,000,000 | $6,800,000 | $10,000,000 | $20,000,000 | $26,000,000 | -$5,700,000 |
| | More Stringent | $310,000,000 | $23,000,000 | $27,000,000 | $67,000,000 | $32,000,000 | $35,000,000 |
| Total | Less Stringent | $6,000,000 | $1,200,000 | $8,300,000 | $9,800,000 | $7,600,000 | $2,300,000 |
| | Final | $76,000,000 | $7,500,000 | $15,000,000 | $26,000,000 | $30,000,000 | -$3,800,000 |
| | More Stringent | $370,000,000 | $27,000,000 | $32,000,000 | $79,000,000 | $35,000,000 | $44,000,000 |

Note: Totals may not sum due to independent rounding. Numbers rounded to two significant digits unless otherwise noted. Negative signs denote cost savings (product recovery exceeding compliance costs, or savings in costs without product recovery). Annual capital cost is the capital recovery costs for each option.

**Table 3-28: Present and Equivalent Annual Values of Compliance Costs of Regulatory Options, 2027-2041 (million 2021$, discounted to 2024)**

| | | 3 Percent | | | | 7 Percent | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Compliance Cost | | Product Recovery | | Compliance Cost | | Product Recovery | |
| Rule | Option Package | PV | EAV | PV | EAV | PV | EAV | PV | EAV |
| NSPS XXa | Less Stringent | $6.5 | $0.5 | $4.2 | $0.4 | $4.3 | $0.5 | $2.8 | $0.3 |
| | Final | $52 | $4.4 | $50 | $4.2 | $34 | $3.8 | $33 | $3.7 |
| | More Stringent | $53 | $4.4 | $51 | $4.2 | $35 | $3.8 | $34 | $3.7 |
| MACT R | Less Stringent | $28 | $2.3 | $3.4 | $0.3 | $19 | $2.1 | $2.4 | $0.3 |
| | Final | $38 | $3.2 | $16 | $1.3 | $27 | $2.9 | $11.0 | $1.3 |
| | More Stringent | $120 | $9.9 | $20 | $1.7 | $84 | $9.2 | $14.0 | $1.6 |
| GACT 6B | Less Stringent | $80 | $6.7 | $80 | $6.7 | $57 | $6.2 | $57 | $6.2 |
| | Final | $230 | $19 | $300 | $25 | $160 | $18 | $210 | $23 |
| | More Stringent | $750 | $63 | $360 | $30 | $530 | $58 | $250 | $28 |
| Total | Less Stringent | $110 | $9.6 | $88 | $7.3 | $80 | $8.8 | $62 | $6.8 |
| | Final | $320 | $27 | $360 | $30 | $220 | $25 | $250 | $28 |
| | More Stringent | $920 | $77 | $430 | $36 | $650 | $71 | $300 | $33 |

Note: Totals may not sum due to independent rounding. Numbers rounded to two significant digits unless otherwise noted.

As shown in Table 3-27, most of the projected cost of the final action comes from the amendments to GACT 6B. This includes 91 percent of the annual capital cost, 71 percent of the operation and maintenance cost, 87 percent of the total capital investment, and 79 percent of the total annualized cost without including revenue from product recovery. GACT 6B also accounts for the bulk of estimated revenue from product recovery (90 percent).

Table 3-28 includes the present value and equivalent annualized value of compliance cost and revenue for the period 2027 to 2041, discounted to 2024 using social discount rates of 3 percent and 7 percent to adhere to OMB guidance in Circular A-4 for regulatory analysis. The present value of the projected compliance cost associated with the final action is $220 million using a 7 percent social discount rate ($320 million using a 3 percent discount rate). Of these totals, roughly 2/3 can be attributed to GACT 6B and 1/6 to each of MACT R and NSPS XXa. The value of product recovery is projected to be substantial, outweighing the projecting compliance costs of the action across the three rules. About 85 percent of this value comes from the amendments to GACT 6B, approximately in line with its share of VOC emissions reductions. Discounted costs and revenue from product recovery for the final options presented cumulatively for the three rules from 2027 to 2041 are contained in Table 3-29 and Table 3-30.

### Table 3-29: Discounted Capital and O&M Costs, Final Options, for NSPS XXa, MACT R, and GACT 6B, 2027-2041 (million 2021$, discounted to 2024)

| | 3 percent | | | | 7 percent | | | |
|---|---|---|---|---|---|---|---|---|
| Year | Capital Cost | Operating and Maintenance Cost | Revenue from Product Recovery | Total Annualized Cost with Revenue from Product Recovery | Capital Cost | Operating and Maintenance Cost | Revenue from Product Recovery | Total Annualized Cost with Revenue from Product Recovery |
| 2027 | $6.9 | $13 | $27 | -$6.9 | $6.1 | $12 | $24 | -$6.1 |
| 2028 | $6.7 | $13 | $27 | -$6.7 | $5.8 | $11 | $23 | -$5.8 |
| 2029 | $6.6 | $13 | $26 | -$6.6 | $5.5 | $11 | $22 | -$5.4 |
| 2030 | $6.5 | $13 | $26 | -$6.4 | $5.2 | $10 | $21 | -$5.1 |
| 2031 | $6.4 | $13 | $25 | -$6.3 | $4.9 | $10 | $19 | -$4.8 |
| 2032 | $6.3 | $12 | $25 | -$6.2 | $4.6 | $9 | $18 | -$4.5 |
| 2033 | $6.2 | $12 | $24 | -$6.0 | $4.4 | $8.7 | $17 | -$4.3 |
| 2034 | $6.1 | $12 | $24 | -$5.9 | $4.2 | $8.3 | $16 | -$4.0 |
| 2035 | $6.0 | $12 | $24 | -$5.8 | $3.9 | $7.8 | $16 | -$3.8 |
| 2036 | $5.9 | $12 | $23 | -$5.6 | $3.7 | $7.4 | $15 | -$3.6 |
| 2037 | $5.8 | $12 | $23 | -$5.5 | $3.5 | $7.0 | $14 | -$3.4 |
| 2038 | $5.7 | $11 | $22 | -$5.4 | $3.3 | $6.7 | $13 | -$3.2 |
| 2039 | $5.6 | $11 | $22 | -$5.3 | $3.1 | $6.3 | $12 | -$3.0 |
| 2040 | $5.5 | $11 | $22 | -$5.1 | $3.0 | $6.0 | $12 | -$2.8 |
| 2041 | $5.4 | $11 | $21 | -$5.0 | $2.8 | $5.7 | $11 | -$2.6 |

Note: Discounted to 2024. Totals may not sum due to independent rounding. Numbers rounded to two significant digits unless otherwise noted. Negative signs denote cost savings (product recovery exceeding compliance costs).

## Table 3-30: Discounted Costs, Final Options, for NSPS XXa, MACT R, and GACT 6B, 2027-2041 (million 2021$, discounted to 2024)

| | 3 percent | | | 7 percent | | |
|---|---|---|---|---|---|---|
| Year | Annualized Costs (w/o Revenue) | Revenue from Product Recovery | Annualized Costs (with Revenue) | Annualized Costs (w/o Revenue) | Revenue from Product Recovery | Annualized Costs (with Revenue) |
| 2027 | $24 | $27 | -$3.4 | $21 | $24 | -$3.1 |
| 2028 | $23 | $27 | -$3.3 | $20 | $23 | -$2.9 |
| 2029 | $23 | $26 | -$3.2 | $19 | $22 | -$2.7 |
| 2030 | $23 | $26 | -$3.1 | $18 | $21 | -$2.5 |
| 2031 | $22 | $25 | -$3.0 | $17 | $19 | -$2.3 |
| 2032 | $22 | $25 | -$2.9 | $16 | $18 | -$2.2 |
| 2033 | $22 | $24 | -$2.8 | $15 | $17 | -$2.0 |
| 2034 | $21 | $24 | -$2.7 | $15 | $16 | -$1.9 |
| 2035 | $21 | $24 | -$2.6 | $14 | $16 | -$1.7 |
| 2036 | $21 | $23 | -$2.6 | $13 | $15 | -$1.6 |
| 2037 | $20 | $23 | -$2.5 | $12 | $14 | -$1.5 |
| 2038 | $20 | $22 | -$2.4 | $12 | $13 | -$1.4 |
| 2039 | $20 | $22 | -$2.3 | $11 | $12 | -$1.3 |
| 2040 | $19 | $22 | -$2.2 | $11 | $12 | -$1.2 |
| 2041 | $19 | $21 | -$2.2 | $10 | $11 | -$1.1 |

Note: Discounted to 2024. Totals may not sum due to independent rounding. Numbers rounded to two significant digits unless otherwise noted. Negative signs denote cost savings (product recovery exceeding compliance costs, or savings in costs without product recovery).

# 4 HUMAN HEALTH BENEFITS OF EMISSIONS REDUCTIONS

## 4.1 Introduction

The emission controls installed to comply with this final action are expected to reduce emissions of volatile organic compounds (VOC) which, in conjunction with $NO_x$ and in the presence of sunlight, form ground-level ozone ($O_3$). This chapter reports the estimated ozone-related benefits of reducing VOC emissions in terms of the number and value of avoided ozone-attributable deaths and illnesses. The potential benefits from reduced ecosystem effects from the reduction in $O_3$ concentrations are not quantified or monetized here. Time and data limitations for quantifying the effect of this action on biomass loss and foliar injury and the ensuing loss of ecosystem services prevent an assessment of the benefits to ecosystems. The EPA provides a qualitative discussion of the benefits of reducing HAP emissions later in this chapter. This discussion can also be found in section 4.7 of the promulgated Affordable Clean Energy (ACE) rule (U.S. EPA, 2019). Finally, we include an analysis of the climate disbenefits for this final action.

The PV of the cumulative monetized health benefits for the final options for all 3 rules is \$240 million for short-term exposure at a 3 percent discount rate and \$140 million at a 7 percent discount rate with an EAV of \$20 million and \$16 million, respectively. The PV of the cumulative monetized health benefits for the final options for all 3 rules are \$2,000 million for long-term exposure at a 3 percent discount rate and \$1,200 million at a 7 percent discount rate with an EAV of \$170 million and \$130 million, respectively. Specific estimates of monetized health estimates for each final rule can be found later in this chapter in section 4.7. All estimates are reported in 2021 dollars. The monetized climate disbenefits resulting from increasing emissions of $CO_2$ as presented in Chapter 3 are included in this chapter in Section 4.6. The monetized climate disbenefits, based on interim benefit per ton estimates as explained later in this RIA chapter, are estimated at \$35 million PV at a 3 percent discount rate (\$2.9 million EAV).

## 4.2 Health Effects from Exposure to Hazardous Air Pollutants (HAP)

In the subsequent sections, we describe the health effects associated with the main HAP of concern from the gasoline distribution sector: benzene (Section 4.2.1), hexane (Section 4.2.2), toluene (Section 4.2.3), 2,2,4-Trimethylpentane (Section 4.2.4), naphthalene (Section 4.2.5), ethylbenzene (Section 4.2.6), xylenes (Section 4.2.7), and cumene (Section 4.2.8). This action is projected to reduce 38,000 tons of HAP emissions over the 2027 through 2041 period, with 31,000 tons of the projected reductions coming from the final amendments to GACT 6B. With the data available, it was not possible to estimate the change in emissions of each individual HAP.

Monetization of the benefits of reductions in cancer incidences requires several important inputs, including central estimates of cancer risks, estimates of exposure to carcinogenic HAP, and estimates of the value of an avoided case of cancer (fatal and non-fatal). Due to methodology and data limitations, we did not attempt to monetize the health benefits of reductions in HAP in this analysis. Instead, we are providing a qualitative discussion of the health effects associated with HAP emitted from sources subject to control under the final action. The EPA remains committed to improving methods for estimating HAP benefits by continuing to explore additional aspects of HAP-related risk from the gasoline distribution sector, including the distribution of that risk.

### 4.2.1 *Benzene*

Benzene is used as a constituent in motor fuels and is found in gasoline service station and motor vehicle exhaust emissions into air. Acute effects of benzene inhalation exposure in humans include neurological symptoms such as drowsiness, dizziness, headaches, and unconsciousness. Exposure to benzene vapor can cause eye, skin, and upper respiratory tract irritation. Chronic exposure to benzene is associated with blood disorders, such as preleukemia and aplastic anemia (ATSDR, 2007). The EPA's IRIS database lists benzene as a known human carcinogen (causing leukemia) by all routes of exposure. IRIS found a causal relationship between benzene exposure and acute lymphocytic leukemia and a suggestive relationship between benzene exposure and chronic non-lymphocytic leukemia and chronic lymphocytic leukemia (U.S. EPA, 2000). IARC has also determined that benzene is a human carcinogen (IARC, 2018).

### 4.2.2 *Hexane*

Hexane is used to extract edible oils from seeds and vegetables, as a special-use solvent, and as a cleaning agent (ATSDR, 1997). Acute (short-term) inhalation exposure of humans to high levels of hexane causes mild central nervous system (CNS) effects, including dizziness, giddiness, slight nausea, and headache. Exposure to hexane vapors can cause dermatitis and irritation of the eyes and throat. Chronic (long-term) exposure to hexane in air is associated with polyneuropathy in humans, with numbness in the extremities, muscular weakness, blurred vision, headache, and fatigue observed (Sittig, 1985). In animal studies, neurotoxic effects as well as pulmonary and nasal lesions have been observed (ATSDR, 1997). EPA determined that hexane was not classifiable as to human carcinogenicity (U.S. EPA, 2005a).

### 4.2.3 *Toluene*

Toluene is added to gasoline, used to produce benzene, and used as a solvent. Automobile emissions are the principal source of toluene to the ambient air. Toluene exposure causes toxicity to the central nervous system (CNS) in both humans and animals for acute (short-term) and chronic (long-term) exposures (ATSDR, 2000). CNS dysfunction and narcosis have been frequently observed in humans acutely exposed to elevated airborne levels of toluene; symptoms include fatigue, sleepiness, headaches, and nausea. CNS depression has been reported to occur in chronic abusers exposed to high levels of toluene. Chronic inhalation exposure of humans to toluene also causes irritation of the upper respiratory tract and eyes, sore throat, dizziness, and headache. Human studies have reported developmental effects, such as CNS dysfunction, attention deficits, and minor craniofacial and limb anomalies, in the children of pregnant women exposed to high levels of toluene or mixed solvents by inhalation (ATSDR, 2000). EPA has concluded that that there is inadequate information to assess the carcinogenic potential of toluene (U.S. EPA, 2005b).

### 4.2.4 *2,2,4-Trimethylpentane*

2,2,4-Trimethylpentane is released to the environment through the manufacture, use, and disposal of products associated with the petroleum and gasoline industry. In an isolated acute exposure incident, 2,2,4-trimethylpentane penetrated the skin of a human which led to skin necrosis and required surgery. In animals acutely exposed via inhalation or injection irritation of the lungs, edema, CNS depression, and hemorrhage have been observed. In rats chronically exposed kidney and liver effects have been observed in rats exposed orally or by inhalation (HSDB, 1993). EPA has not classified 2,2,4-trimethylpentane with respect to potential carcinogenicity (U.S. EPA, 2007).

### 4.2.5 *Napthalene*

Naphthalene is used in the production of phthalic anhydride; it is also used in mothballs. Acute exposure of humans to naphthalene by inhalation, ingestion, and dermal contact is associated with hemolytic anemia and neurological damage. Cataracts have also been reported in workers acutely exposed to naphthalene by inhalation and ingestion. Chronic (long-term) exposure of workers and rodents to naphthalene has been reported to cause cataracts and damage to the retina. Hemolytic anemia has been reported in infants born to mothers who “sniffed” and ingested naphthalene (as mothballs) during pregnancy. Inflammation, hyperplasia, and lesions have been reported in the nose of rats exposed chronically to naphthalene (ATSDR 2005; EPA, 1998). Based on the 1996 Final Guidelines for Carcinogen Risk Assessment, EPA determined there was insufficient information to assess the carcinogenic potential of naphthalene (U.S EPA, 1998). IARC classified naphthalene as possibly carcinogenic to humans, Group 2B (IARC, 2002).

### 4.2.6 *Ethylbenzene*

Acute (short-term) exposure to ethylbenzene in humans results in respiratory effects, such as throat irritation and chest constriction, irritation of the eyes, and neurological effects such as dizziness. Chronic (long-term) exposure to ethylbenzene by inhalation in humans has shown conflicting results regarding its effects on the blood. Animal studies have reported effects on the blood, liver, and kidneys from chronic inhalation exposure to ethylbenzene (ATSDR, 2010). Limited information is available on the carcinogenic effects of ethylbenzene in humans. In a study by the National Toxicology Program (NTP), exposure to ethylbenzene by inhalation resulted in an increased incidence of kidney and testicular tumors in rats, and lung and liver tumors in mice (NTP, 1999). EPA has classified ethylbenzene as a Group D, not classifiable as to human carcinogenicity (U.S. EPA, 1988). IARC classified ethylbenzene as a Group 2B carcinogen, possibly carcinogenic to humans (IARC, 2000).

### 4.2.7 *Xylenes*

Xylenes are released into the atmosphere as fugitive emissions from industrial sources, from auto exhaust, and through volatilization from their use as solvents. Acute (short-term) inhalation exposure to mixed xylenes in humans results in irritation of the eyes, nose, and throat, gastrointestinal effects, eye irritation, and neurological effects. Chronic (long-term) inhalation exposure of humans to mixed xylenes results primarily in CNS effects, such as headache, dizziness, fatigue, tremors, and incoordination; respiratory, cardiovascular, and kidney effects have also been reported (ATSDR, 2007; U.S EPA, 2003). EPA determined that mixed xylenes are not classifiable as to human carcinogenicity (U.S EPA, 2003).

### 4.2.8 *Cumene*

Cumene is used in petroleum products. Acute (short-term) inhalation exposure to cumene may cause headaches, dizziness, drowsiness, slight incoordination, and unconsciousness in humans. Cumene is a potent central nervous system (CNS) depressant and a skin and eye irritant (U.S. Department of Health and Human Services, 1993). No information is available on the chronic (long-term) effects of cumene in humans. Animal studies have reported increased liver, kidney, and adrenal weights from inhalation exposure to cumene. EPA has classified cumene as a Group D, not classifiable as to human carcinogenicity (U.S. EPA, 1997). IARC has classified cumene as possibly carcinogenic to humans (Group 2B) based on sufficient evidence of carcinogenicity in animals. Exposure to cumene by whole-body inhalation caused increased incidence of tumors in the respiratory tract, kidney, spleen, and liver in animal studies (IARC, 2013).

### 4.2.9 *Other Air Toxics*

In addition to the compounds described above, other toxic compounds might be affected by this action. Information regarding the health effects of those compounds can be found in the EPA's IRIS database[37].

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[37] U.S. EPA Integrated Risk Information System (IRIS) database is available at www.epa.gov/iris. Accessed March 30, 2022.

## 4.3 VOC-related Human Health Benefits

This section summarizes the EPA's approach to estimating the incidence and economic value of the ozone-related benefits estimated for this action. *The Regulatory Impact Analysis for the Proposed National Emission Standards for Hazardous Air Pollutants: Coal- and Oil-Fired Electric Utility Steam Generating Units Review of the Residual Risk and Technology Review* (U.S. EPA, 2023a) and its corresponding Technical Support Document (TSD) *Estimating $PM_{2.5}$ - and Ozone – Attributable Health Benefits* (TSD) (U.S. EPA, 2023b) provide a full discussion of the EPA's approach for quantifying the incidence and value of estimated air pollution-related health impacts. In these documents, the reader can find the rationale for selecting the health endpoints quantified; the demographic, health and economic data applied in the environmental Benefits Mapping and Analysis Program—Community Edition (BenMAP-CE); modeling assumptions; and the EPA's techniques for quantifying uncertainty.

Implementing this action will affect the distribution of ozone concentrations throughout the U.S.; this includes locations both meeting and exceeding the NAAQS for $O_3$. This RIA estimates avoided $O_3$-related health impacts that are distinct from those reported in the RIAs for the $O_3$ NAAQS (U.S. EPA, 2015a). The $O_3$ NAAQS RIAs hypothesize, but do not predict, the benefits and costs of strategies that States may choose to enact when implementing a revised NAAQS; these costs and benefits are illustrative and cannot be added to the costs and benefits of policies that prescribe specific emission control measures.

### 4.3.1 *Estimating Ozone Related Health Impacts*

We estimate the quantity and economic value of air pollution-related effects by estimating counts of air pollution-attributable cases of adverse health outcomes, assigning dollar values to these counts, and assuming that each outcome is independent of one another. We construct these estimates by adapting primary research—specifically, air pollution epidemiology studies and economic value studies—from similar contexts. This approach is sometimes referred to as "benefits transfer." Below we describe the procedure we follow for: (1) selecting air pollution health endpoints to quantify; (2) calculating counts of air pollution effects using a health impact function; (3) specifying the health impact function with concentration-response parameters drawn from the epidemiological literature.

#### *4.3.1.1 Selecting air pollution health endpoints to quantify*

As a first step in quantifying $O_3$-related human health impacts, the EPA consults the *Integrated Science Assessment for Ozone* (Ozone ISA) (U.S. EPA, 2020) as summarized in the TSD for *The Regulatory Impact Analysis for the Proposed National Emission Standards for Hazardous Air Pollutants: Coal- and Oil-Fired Electric Utility Steam Generating Units Review of the Residual Risk and Technology Review* (U.S. EPA, 2023b). This document synthesizes the toxicological, clinical, and epidemiological evidence to determine whether each pollutant is causally related to an array of adverse human health outcomes associated with either acute (i.e., hours or days-long) or chronic (i.e., years-long) exposure. For each outcome, the ISA reports this relationship to be causal, likely to be causal, suggestive of a causal relationship, inadequate to infer a causal relationship, or not likely to be a causal relationship.

In brief, the ISA for ozone found short-term (less than one month) exposures to ozone to be causally related to respiratory effects, a “likely to be causal” relationship with metabolic effects and a “suggestive of, but not sufficient to infer, a causal relationship” for central nervous system effects, cardiovascular effects, and total mortality. The ISA reported that long-term exposures (one month or longer) to ozone are “likely to be causal” for respiratory effects including respiratory mortality, and a “suggestive of, but not sufficient to infer, a causal relationship” for cardiovascular effects, reproductive effects, central nervous system effects, metabolic effects, and total mortality.

The EPA estimates the incidence of air pollution effects for those health endpoints listed above where the ISA classified the impact as either causal or likely-to-be-causal. Table 4-1 reports the effects we quantified and those we did not quantify in this RIA. The list of benefit categories not quantified shown in that table is not exhaustive. And, among the effects we quantified, we might not have been able to completely quantify either all human health impacts or economic values. The table below omits any welfare effects such as biomass loss and foliar injury. These effects are described in Chapter 7 of the Ozone NAAQS RIA (2015).

**Table 4-1: Human Health Effects of Ambient Ozone**

| Category | Effect | Effect Quantified | Effect Monetized | More Information |
|---|---|---|---|---|
| Mortality from exposure to ozone | Premature respiratory mortality from short-term exposure (0-99) | ✓ | ✓ | Ozone ISA[1] |
| | Premature respiratory mortality from long-term exposure (age 30–99) | ✓ | ✓ | Ozone ISA |
| Nonfatal morbidity from exposure to ozone | Hospital admissions—respiratory (ages 65-99) | ✓ | ✓ | Ozone ISA |
| | Emergency department visits—respiratory (ages 0-99) | ✓ | ✓ | Ozone ISA |
| | Asthma onset (0-17) | ✓ | ✓ | Ozone ISA |
| | Asthma symptoms/exacerbation (asthmatics age 5-17) | ✓ | ✓ | Ozone ISA |
| | Allergic rhinitis (hay fever) symptoms (ages 3-17) | ✓ | ✓ | Ozone ISA |
| | Minor restricted-activity days (age 18–65) | ✓ | ✓ | Ozone ISA |
| | School absence days (age 5–17) | ✓ | ✓ | Ozone ISA |
| | Decreased outdoor worker productivity (age 18–65) | — | — | Ozone ISA[2] |
| | Metabolic effects (e.g., diabetes) | — | — | Ozone ISA[2] |
| | Other respiratory effects (e.g., premature aging of lungs) | — | — | Ozone ISA[2] |
| | Cardiovascular and nervous system effects | — | — | Ozone ISA[2] |
| | Reproductive and developmental effects | — | — | Ozone ISA[2] |

[1] We assess these benefits qualitatively due to data and resource limitations for this analysis. In other analyses we quantified these effects as a sensitivity analysis.

[2] We assess these benefits qualitatively because we do not have sufficient confidence in available data or methods.

#### *4.3.1.2 Quantifying Cases of Ozone-Attributable Premature Mortality*

Mortality risk reductions account for the majority of monetized ozone-related benefits. For this reason, this subsection and the following provide a brief background of the scientific assessments that underly the quantification of these mortality risks and identifies the risk studies used to quantify them in this RIA for ozone. As noted above, the *Estimating $PM_{2.5}$- and Ozone-Attributable Health Benefits* TSD describes fully the Agency's approach for quantifying the number and value of ozone air pollution-related impacts, including additional discussion of how the Agency selected the risk studies used to quantify them in this RIA. The TSD also includes additional discussion of the assessments that support quantification of these mortality risk than provide here.

In 2008, the National Academies of Science (NRC 2008) issued a series of recommendations to EPA regarding the procedure for quantifying and valuing ozone-related mortality due to short-term exposures. Chief among these was that "…short-term exposure to ambient ozone is likely to contribute to premature deaths" and the committee recommended that "ozone-related mortality be included in future estimates of the health benefits of reducing ozone exposures…" The NAS also recommended that "…the greatest emphasis be placed on the multicity and [National Mortality and Morbidity Air Pollution Studies (NMMAPS)] …studies without exclusion of the meta-analyses" (NRC 2008). Prior to the 2015 Ozone NAAQS RIA, the Agency estimated ozone-attributable premature deaths using an NMMAPS-based analysis of total mortality (Bell et al. 2004), two multi-city studies of cardiopulmonary and total mortality (Huang et al. 2004; Schwartz 2005) and effect estimates from three meta-analyses of non-accidental mortality (Bell et al. 2005; Ito et al. 2005; Levy et al. 2005). Beginning with the 2015 Ozone NAAQS RIA, the Agency began quantifying ozone-attributable premature deaths using two newer multi-city studies of non-accidental mortality (Smith et al. 2009; Zanobetti and Schwartz 2008) and one long-term cohort study of respiratory mortality (Jerrett et al. 2009). The 2020 Ozone ISA included changes to the causality relationship determinations between short-term exposures and total mortality, as well as including more recent epidemiologic analyses of long-term exposure effects on respiratory mortality (U.S. EPA, 2020). In this RIA, as described in the corresponding TSD, two estimates of ozone-attributable respiratory deaths from short-term exposures are estimated using the risk estimate parameters from Zanobetti et al. (2008) and Katsouyanni et al. (2009). Ozone-attributable respiratory deaths from long-term exposures are estimated using Turner et al. (2016). Due to time and resource limitations, we were unable to reflect the warm season defined by Zanobetti et al. (2008) as June-August. Instead, we apply this risk estimate to our standard warm season of May-September.

#### *4.3.1.3 Economic Valuation*

After quantifying the change in adverse health impacts, we estimate the economic value of these avoided impacts. Reductions in ambient concentrations of air pollution generally lower the risk of future adverse health effects by a small amount for a large population. Therefore, the appropriate economic measure is willingness to pay (WTP) for changes in risk of a health effect. For some health effects, such as hospital admissions, WTP estimates are generally not available, so we use the cost of treating or mitigating the effect. These cost-of-illness (COI) estimates generally (although not necessarily in every case) understate the true value of reductions in risk of a health effect. They tend to reflect the direct expenditures related to treatment but not the value of avoided pain and suffering from the health effect. The unit values applied in this analysis are provided in Section 5.1 of the TSD for the Revised Cross State Update rule (U.S. EPA, 2021).

Avoided premature deaths account for 95 percent of monetized Ozone-related benefits. The economics literature concerning the appropriate method for valuing reductions in premature mortality risk is still developing. The value for the projected reduction in the risk of premature mortality is the subject of continuing discussion within the economics and public policy analysis community. Following the advice of the SAB's Environmental Economics Advisory Committee (SAB-EEAC), the EPA currently uses the value of statistical life (VSL) approach in calculating estimates of mortality benefits, because we believe this calculation provides the most reasonable single estimate of an individual's WTP for reductions in mortality risk (U.S. EPA–SAB, 2000). The VSL approach is a summary measure for the value of small changes in mortality risk experienced by a large number of people.

The EPA continues work to update its guidance on valuing mortality risk reductions and consulted several times with the SAB-EEAC on the issue. Until updated guidance is available, the EPA determined that a single, peer-reviewed estimate applied consistently best reflects the SAB-EEAC advice it has received. Therefore, the EPA applies the VSL that was vetted and endorsed by the SAB in the *Guidelines for Preparing Economic Analyses* while the EPA continues its efforts to update its guidance on this issue (U.S. EPA, 2016). This approach calculates a mean value across VSL estimates derived from 26 labor market and contingent valuation studies published between 1974 and 1991. The mean VSL across these studies is $10.7 million (2016$).[38]

The EPA is committed to using scientifically sound, appropriately reviewed evidence in valuing changes in the risk of premature death and continues to engage with the SAB to identify scientifically sound approaches to update its mortality risk valuation estimates. Most recently, the Agency final new meta-analytic approaches for updating its estimates which were subsequently reviewed by the SAB-EEAC. The EPA is taking the SAB's formal recommendations under advisement (U.S. EPA, 2017b).

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[38] In 1990$, this base VSL is $4.8 million. In 2016$, this base VSL is $10.7 million.

Because short-term ozone-related premature mortality occurs within the analysis year, the estimated ozone-related benefits are identical for all discount rates. When valuing changes in ozone-attributable deaths using the Turner et al. (2016) study, we follow advice provided by the Health Effects Subcommittee of the SAB, which found that "…there is no evidence in the literature to support a different cessation lag between ozone and particulate matter. The HES therefore recommends using the same cessation lag structure and assumptions as for particulate matter when utilizing cohort mortality evidence for ozone" (U.S. EPA-SAB 2010).

These estimated health benefits do not account for the influence of future changes in the climate on ambient concentrations of pollutants (USGCRP 2016). For example, recent research suggests that future changes to climate may create conditions more conducive to forming ozone. The estimated health benefits also do not consider the potential for climate-induced changes in temperature to modify the relationship between ozone and the risk of premature mortality (Jhun et al. 2014; Ren et al. 2008a, 2008b).

#### *4.3.1.4 Benefit-per-Ton Estimates*

Because the estimated emissions reductions due to this rule are small and because we cannot be confident of the location of new facilities under the NSPS, EPA elected to use the benefit per-ton (BPT) approach. BPT estimates provide the total monetized human health benefits (the sum of premature mortality and premature morbidity) of reducing one ton of the VOC precursor for ozone from a specified source. Specifically, in this analysis, we multiplied the estimates from the "Gasoline Distribution" sector by the corresponding emission reductions. The method used to derive these estimates is described in the BPT Technical Support Document (BPT TSD) on *Estimating the Benefit per Ton of Reducing Directly-Emitted* $PM_{2.5}$*,* $PM_{2.5}$ *Precursors and Ozone Precursors from 21 Sectors* (U.S. EPA, 2023c). One limitation of using the BPT approach is an inability to provide estimates of the health benefits associated with exposure to HAP, CO, and $NO_2$.

As noted below in the characterization of uncertainty, all BPT estimates have inherent limitations. Specifically, all national-average BPT estimates reflect the geographic distribution of the modeled emissions, which may not exactly match the emission reductions that would occur due to the action, and they may not reflect local variability in population density, meteorology, exposure, baseline health incidence rates, or other local factors for any specific location. Given sector specific air quality modeling and the small changes in emissions considered in this action, the difference in the quantified health benefits that result from the BPT approach compared with if EPA had used a full-form air quality model should be minimal.

The EPA systematically compared the changes in benefits, and concentrations where available, from its BPT technique and other reduced-form techniques to the changes in benefits and concentrations derived from full-form photochemical model representation of a few different specific emissions scenarios. Reduced form tools are less complex than the full air quality modeling, requiring less agency resources and time. That work, in which we also explore other reduced form models is referred to as the “Reduced Form Tool Evaluation Project” (Project), began in 2017, and the initial results were available at the end of 2018. The Agency’s goal was to create a methodology by which investigators could better understand the suitability of alternative reduced-form air quality modeling techniques for estimating the health impacts of criteria pollutant emissions changes in the EPA’s benefit-cost analysis, including the extent to which reduced form models may over- or under-estimate benefits (compared to full-scale modeling) under different scenarios and air quality concentrations. The EPA Science Advisory Board (SAB) recently convened a panel to review this report.[39] In particular, the SAB will assess the techniques the Agency used to appraise these tools; the Agency’s approach for depicting the results of reduced-form tools; and steps the Agency might take for improving the reliability of reduced-form techniques for use in future Regulatory Impact Analyses (RIAs).

The scenario-specific emission inputs developed for this project are currently available online. The study design and methodology are described in the final report summarizing the results of the project (IEc, 2019. *Evaluating Reduced-Form Tools for Estimating Air Quality Benefits. Final Report*). Results of this project found that total $PM_{2.5}$ BPT values were within approximately 10 percent of the health benefits calculated from full-form air quality modeling when analyzing the Pulp and Paper sector, a sector used as an example for evaluating the application of the new methodology in the final report. The ratios for individual species varied, and the report found that the ratio for the directly emitted $PM_{2.5}$ for the pulp and paper sector was 0.7 for the BPT approach compared to 1.0 for full air quality modeling combined with BenMAP.

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[39] 85 FR 23823. April 29, 2020.

This provides some initial understanding of the uncertainty which is associated with using the BPT approach instead of full air quality modeling.

### 4.3.2 *Ozone Vegetation Effects*

Exposure to ozone has been found to be associated with a wide array of vegetation and ecosystem effects in the published literature (U.S. EPA, 2020). Sensitivity to ozone is highly variable across species, with over 66 vegetation species identified as “ozone-sensitive,” many of which occur in state and national parks and forests. These effects include those that cause damage to, or impairment of, the intended use of the plant or ecosystem. Such effects are considered adverse to public welfare and can include reduced growth and/or biomass production in sensitive trees, reduced yield and quality of crops, visible foliar injury, changed to species composition, and changes in ecosystems and associated ecosystem services.

### 4.3.3 *Ozone Climate Effects*

Ozone is a well-known short-lived climate forcing GHG (U.S. EPA, 2013). Stratospheric ozone (the upper ozone layer) is beneficial because it protects life on Earth from the sun’s harmful ultraviolet (UV) radiation. In contrast, tropospheric ozone (ozone in the lower atmosphere) is a harmful air pollutant that adversely affects human health and the environment and contributes significantly to regional and global climate change. Due to its short atmospheric lifetime, tropospheric ozone concentrations exhibit large spatial and temporal variability (U.S. EPA, 2009b). The IPCC AR5 estimated that the contribution to current warming levels of increased tropospheric ozone concentrations resulting from human methane, $NO_X$, and VOC emissions was 0.5 $W/m^2$, or about 30 percent as large a warming influence as elevated $CO_2$ concentrations. This quantifiable influence of ground level ozone on climate leads to increases in global surface temperature and changes in hydrological cycles.

## 4.4 VOC-Related Ozone Benefits Results

Table 4-2 lists the estimated ozone-related benefits per ton applied in this national level analysis. Benefits are discounted at 3 and 7 percent for a 2021 currency year. Table 4-3 presents the estimated ozone benefits from emission reductions for the GACT 6B (area source) portion of this action. Table 4-4 presents the estimated ozone benefits from emission reductions for the MACT R (major source) portion of this action. Table 4-5 shows the estimated ozone-related benefits per ton applied in this analysis for affected the NSPS XXa (new units) portion of this action, respectively. Finally, Table 4-6 presents the total health related benefits of reducing emissions of ozone for all three rules. For all estimates, we summarize the monetized ozone-related health benefits using discount rates of 3 percent and 7 percent for both short-term and long-term effects for the 15-year analysis period of these rules discounted back to 2024 and rounded to 2 significant figures. The PV of the cumulative monetized health benefits for the final options for all 3 rules are $240 million for short-term exposure at a 3 percent discount rate and $140 million at a 7 percent discount rate with an EAV of $20 million and $16 million, respectively. The PV of the cumulative monetized health benefits for the final options for all 3 rules are $2,000 million for long-term exposure at a 3 percent discount rate and $1,200 million at a 7 percent discount rate with an EAV of $170 million and $130 million, respectively. For the full set of underlying calculations see the “Gasoline Distribution Benefits workbook”, available in the docket for the final rule (docket number EPA-HQ-OAR-2020-0371). Undiscounted benefits for final, less stringent, and more stringent alternative options for all rules cumulatively are in Table 4-7, Table 4-8, and Table 4-9 below.

The tables below do not include non-monetized benefits associated with the rule, including any benefits associated with HAP emission reductions (including reductions of benzene, hexane, toluene, 2,2,4-trimethylpentane, napthalene, ethylbenzene, xylenes, and cumene). For the estimated HAP emissions reduction, see Section 3.4. For a discussion of the health effects of these HAP, see Section 4.2. These non-monetized benefits also include ozone climate impacts and benefits to ecosystem services associated with improvements in biomass loss and foliar injury.

**Table 4-2: Gasoline Distribution: Benefit per Ton Estimates of Ozone-Attributable Premature Mortality and Illness, 2027-2041 (2021$)**

|  | Discount Rate |  |  |  |  |  |
|---|---|---|---|---|---|---|
| **Year** | **3 Percent** |  |  | **7 Percent** |  |  |
| **2025** | $934 | and | $7,198 | $831 | and | $6,436 |
| **2030** | $1,001 | and | $8,003 | $896 | and | $7,166 |
| **2035** | $1,069 | and | $8,892 | $955 | and | $7,960 |
| **2040** | $1,122 | and | $9,675 | $1,009 | and | $8,670 |

Note: The standard reporting convention for EPA benefits is to round all results to two significant figures. Here, we report all significant figures so that readers may reproduce the results reported below.

**Table 4-3: Gasoline Distribution GACT 6B: Monetized Benefits Estimates of Ozone-Attributable Premature Mortality and Illness (million 2021$)[a,b]**

| | GACT 6B | | | | | |
|---|---|---|---|---|---|---|
| | Less Stringent Regulatory Option | | Final Regulatory Option | | More Stringent Regulatory Option | |
| | Discount Rate | | Discount Rate | | Discount Rate | |
| | 3 Percent | 7 Percent | 3 Percent | 7 Percent | 3 Percent | 7 Percent |
| PV | 58 and 460 | 34 and 280 | 200 and 1,600 | 120 and 980 | 250 and 2,000 | 150 and 1,200 |
| EAV | 4.9 and 39 | 3.7 and 30 | 17 and 140 | 13 and 110 | 21 and 170 | 16 and 130 |

[a] Discounted to 2024. Calculations of PV and EAV reflect benefits estimates for the 2027-2041 analysis timeframe described in Chapter 1 of this RIA.
[b] Rounded to 2 significant figures.

**Table 4-4: Gasoline Distribution MACT R: Monetized Benefits Estimates of Ozone-Attributable Premature Mortality and Illness (million 2021$)[a,b]**

| | MACT R | | | | | |
|---|---|---|---|---|---|---|
| | Less Stringent Regulatory Option | | Final Regulatory Option | | More Stringent Regulatory Option | |
| | Discount Rate | | Discount Rate | | Discount Rate | |
| | 3 Percent | 7 Percent | 3 Percent | 7 Percent | 3 Percent | 7 Percent |
| PV | 2.3 and 19 | 1.4 and 11 | 11 and 87 | 6.3 and 52 | 13 and 110 | 8.0 and 65 |
| EAV | 0.19 and 1.6 | 0.15 and 1.2 | 0.89 and 7.3 | 0.70 and 5.8 | 1.1 and 9.0 | 0.87 and 7.1 |

[a] Discounted to 2024. Calculations of PV and EAV reflect benefits estimates for the 2027-2041 analysis timeframe described in Chapter 1 of this RIA.
[b] Rounded to 2 significant figures.

## Table 4-5: Gasoline Distribution NSPS XXa: Monetized Benefits Estimates of Ozone-Attributable Premature Mortality and Illness (million 2021$)[a,b]

| | NSPS XXa | | | | | |
|---|---|---|---|---|---|---|
| | Less Stringent Regulatory Option | | Final Regulatory Option | | More Stringent Regulatory Option | |
| | Discount Rate | | Discount Rate | | Discount Rate | |
| | 3 Percent | 7 Percent | 3 Percent | 7 Percent | 3 Percent | 7 Percent |
| PV | 2.9 and 23 | 1.6 and 13 | 34 and 280 | 19 and 160 | 34 and 280 | 19 and 160 |
| EAV | 0.24 and 2.0 | 0.17 and 1.4 | 2.8 and 24 | 2.1 and 17 | 2.9 and 24 | 2.1 and 18 |

[a] Discounted to 2024. Calculations of PV and EAV reflect benefits estimates for the 2027-2041 analysis timeframe described in Chapter 1 of this RIA.
[b] Rounded to 2 significant figures.

## Table 4-6: Gasoline Distribution All Rules: Monetized Benefits Estimates of Ozone-Attributable Premature Mortality and Illness (million 2021$)[a,b]

| | All Rules | | | | | |
|---|---|---|---|---|---|---|
| | Less Stringent Regulatory Option | | Final Regulatory Option | | More Stringent Regulatory Option | |
| | Discount Rate | | Discount Rate | | Discount Rate | |
| | 3 Percent | 7 Percent | 3 Percent | 7 Percent | 3 Percent | 7 Percent |
| PV | 63 and 500 | 37 and 300 | 240 and 2,000 | 140 and 1,200 | 290 and 2,400 | 180 and 1,400 |
| EAV | 5.3 and 42 | 4.0 and 33 | 20 and 170 | 16 and 130 | 25 and 200 | 19 and 160 |

[a] Discounted to 2024. Calculations of PV and EAV reflect benefits estimates for the 2027-2041 analysis timeframe described in Chapter 1 of this RIA.
[b] Rounded to 2 significant figures.

### Table 4-7: Gasoline Distribution All Rules, Final Regulatory Options: Undiscounted Monetized Benefits Estimates of Ozone-Attributable Premature Mortality and Illness (million 2021$)

| Year | 3% | | 7% | |
|---|---|---|---|---|
| 2026 | $18 | $140 | $16 | $130 |
| 2027 | $20 | $160 | $18 | $140 |
| 2028 | $20 | $160 | $18 | $140 |
| 2029 | $20 | $160 | $18 | $150 |
| 2030 | $21 | $160 | $18 | $150 |
| 2031 | $21 | $170 | $19 | $150 |
| 2032 | $22 | $190 | $20 | $170 |
| 2033 | $23 | $190 | $20 | $170 |
| 2034 | $23 | $190 | $21 | $170 |
| 2035 | $23 | $190 | $21 | $170 |
| 2036 | $24 | $200 | $21 | $180 |
| 2037 | $25 | $220 | $22 | $190 |
| 2038 | $25 | $220 | $23 | $200 |
| 2039 | $26 | $220 | $23 | $200 |
| 2040 | $26 | $220 | $23 | $200 |

Note: Rounded to 2 significant figures.

### Table 4-8: Gasoline Distribution All Rules, Less Stringent Regulatory Options: Undiscounted Monetized Benefits Estimates of Ozone-Attributable Premature Mortality and Illness (million 2021$)

| Year | 3% | | 7% | |
|---|---|---|---|---|
| 2026 | $4.9 | $37 | $4.3 | $34 |
| 2027 | $5.2 | $42 | $4.7 | $37 |
| 2028 | $5.3 | $42 | $4.7 | $38 |
| 2029 | $5.3 | $42 | $4.7 | $38 |
| 2030 | $5.3 | $42 | $4.7 | $38 |
| 2031 | $5.3 | $43 | $4.8 | $38 |
| 2032 | $5.7 | $47 | $5.1 | $42 |
| 2033 | $5.7 | $48 | $5.1 | $43 |
| 2034 | $5.7 | $48 | $5.1 | $43 |
| 2035 | $5.8 | $48 | $5.2 | $43 |
| 2036 | $5.8 | $48 | $5.2 | $43 |
| 2037 | $6.1 | $53 | $5.5 | $47 |
| 2038 | $6.1 | $53 | $5.5 | $47 |
| 2039 | $6.1 | $53 | $5.5 | $48 |
| 2040 | $6.2 | $53 | $5.5 | $48 |

Note: Rounded to 2 significant figures.

**Table 4-9: Gasoline Distribution All Rules, More Stringent Regulatory Options: Undiscounted Monetized Benefits Estimates of Ozone-Attributable Premature Mortality and Illness (million 2021$)**

| Year | 3% | | 7% | |
|---|---|---|---|---|
| 2026 | $22 | $170 | $20 | $150 |
| 2027 | $24 | $190 | $22 | $170 |
| 2028 | $24 | $200 | $22 | $180 |
| 2029 | $25 | $200 | $22 | $180 |
| 2030 | $25 | $200 | $22 | $180 |
| 2031 | $25 | $200 | $23 | $180 |
| 2032 | $27 | $230 | $24 | $200 |
| 2033 | $28 | $230 | $25 | $200 |
| 2034 | $28 | $230 | $25 | $210 |
| 2035 | $28 | $230 | $25 | $210 |
| 2036 | $28 | $240 | $25 | $210 |
| 2037 | $30 | $260 | $27 | $230 |
| 2038 | $30 | $260 | $27 | $230 |
| 2039 | $31 | $260 | $27 | $240 |
| 2040 | $31 | $270 | $28 | $240 |

Note: Rounded to 2 significant figures.

## 4.5 Characterization of Uncertainty in the Monetized VOC Benefits

In any complex analysis using estimated parameters and inputs from a variety of models, there are likely to be many sources of uncertainty. This analysis is no exception. This analysis includes many data sources as inputs, including emission inventories, air quality data from models (with their associated parameters and inputs), population data, population estimates, health effect estimates from epidemiology studies, economic data for monetizing benefits, and assumptions regarding the future state of the world (i.e., regulations, technology, and human behavior). Each of these inputs are uncertain and generate uncertainty in the benefits estimate. When the uncertainties from each stage of the analysis are compounded, even small uncertainties can have large effects on the total quantified benefits. Therefore, the estimates of annual benefits should be viewed as representative of the magnitude of benefits expected, rather than the actual benefits that would occur every year.

This RIA does not include the type of detailed uncertainty assessment found in the TSD for the 2022 PM NAAQS Reconsideration Proposal RIA *Estimating PM2.5- and Ozone-Attributable Health Benefits* (U.S. EPA, 2023d) because we lack the necessary air quality input and monitoring data. Criteria pollutant emissions changes were relatively small on a percentage basis, which made air quality modeling impractical. However, the results of the uncertainty analyses presented in the 2021 Revised Cross State Update RIA can provide some information regarding the uncertainty inherent in the benefits results presented in this analysis.

## 4.6 Climate Impacts

With the additional operation of control devices associated with the final action, $CO_2$ emissions will be generated as a result of the additional electricity required to operate them. The estimate of additional $CO_2$ emissions is presented in Chapter 3. There will be climate disbenefits associated with these additional $CO_2$ emissions that we calculate using an interim measure of the social cost of carbon (SC-$CO_2$).

Elevated concentrations of $CO_2$ and other greenhouse gases (GHGs) in the atmosphere have been warming the planet, leading to changes in the Earth's climate including changes in the frequency and intensity of heat waves, precipitation, and extreme weather events, rising seas, and retreating snow and ice. The well-documented atmospheric changes due to anthropogenic GHG emissions are changing the climate at a pace and in a way that threatens human health, society, and the natural environment.

Extensive information on climate change is available in the scientific assessments and EPA documents that are briefly described in this section, as well as in the technical and scientific information supporting them. One of those documents is EPA's 2009 Endangerment and Cause or Contribute Findings for Greenhouse Gases Under section 202(a) of the CAA (74 FR 66496, December 15, 2009). In the 2009 Endangerment Finding, the Administrator found under section 202(a) of the CAA that elevated atmospheric concentrations of six key well-mixed GHGs – $CO_2$, methane ($CH_4$), nitrous oxide ($N_2O$), HFCs, perfluorocarbons (PFCs), and sulfur hexafluoride (SF6) – "may reasonably be anticipated to endanger the public health and welfare of current and future generations" (74 FR 66523). The 2009 Endangerment Finding, together with the extensive scientific and technical evidence in the supporting record, documented that climate change caused by human emissions of GHGs threatens the public health of the U.S. population. It explained that by raising average temperatures, climate change increases the likelihood of heat waves, which are associated with increased deaths and illnesses (74 FR 66497). While climate change also increases the likelihood of reductions in cold-related mortality, evidence indicates that the increases in heat mortality will be larger than the decreases in cold mortality in the U.S.

(74 FR 66525). The 2009 Endangerment Finding further explained that compared with a future without climate change, climate change is expected to increase tropospheric ozone pollution over broad areas of the U.S., including in the largest metropolitan areas with the worst tropospheric ozone problems, and thereby increase the risk of adverse effects on public health (74 FR 66525). Climate change is also expected to cause more intense hurricanes and more frequent and intense storms of other types and heavy precipitation, with impacts on other areas of public health, such as the potential for increased deaths, injuries, infectious and waterborne diseases, and stress-related disorders (74 FR 66525). Children, the elderly, and the poor are among the most vulnerable to these climate-related health effects (74 FR 66498).

The 2009 Endangerment Finding also documented, together with the extensive scientific and technical evidence in the supporting record, that climate change touches nearly every aspect of public welfare in the U.S. with resulting economic costs, including: changes in water supply and quality due to changes in drought and extreme rainfall events; increased risk of storm surge and flooding in coastal areas and land loss due to inundation; increases in peak electricity demand and risks to electricity infrastructure; and the potential for significant agricultural disruptions and crop failures (though offset to some extent by carbon fertilization). These impacts are also global and the effects of climate change occurring outside the U.S. are reasonably expected to impact the U.S. population. (74 FR 66530).

In 2016, the Administrator issued a similar finding for GHG emissions from aircraft under section 231(a)(2)(A) of the CAA. In the 2016 Endangerment Finding, the Administrator found that the body of scientific evidence amassed in the record for the 2009 Endangerment Finding compellingly supported a similar endangerment finding under CAA section 231(a)(2)(A), and also found that the science assessments released between the 2009 and the 2016 Findings ‘‘strengthen and further support the judgment that GHGs in the atmosphere may reasonably be anticipated to endanger the public health and welfare of current and future generations’’ (81 FR 54424).

Since the 2016 Endangerment Finding, the climate change impacts have continued to intensify, with new observational records being set for several climate indicators such as global average surface temperatures, GHG concentrations, and sea level rise. Moreover, heavy precipitation events have increased in the eastern United States while agricultural and ecological drought has increased in the western United States along with more intense and larger wildfires.[40] Recent assessment reports discuss how these observed trends are increasingly attributed to human-induced climate change[41] and are expected to continue and worsen over the coming century, with stronger trends under higher warming scenarios (see e.g., USGCRP (2018) [42], IPCC (2022a, 2022b)). Climate impacts that occur outside U.S. borders also increasingly impact the welfare of individuals and firms that reside in the United States because of their connection to the global economy. This will occur through the effect of climate change on international markets, trade, tourism, and other activities. For example, supply chain disruptions are a prominent pathway through which U.S. business and consumers are, and will continue to be, affected by climate change impacts abroad (USGCRP 2018, U.S. DOD 2021). Additional climate change induced international spillovers can occur through pathways such as damages across transboundary resources, economic and political destabilization, and global migration that can lead to adverse impacts on U.S. national security, public health, and humanitarian concerns (U.S. DOD 2014, CCS 2018). These and other trends highlight the increased risk already being experienced due to climate change as detailed in the 2009 and 2016 Endangerment Findings. Additionally, new major scientific assessments continue to advance our understanding of the climate system and the impacts that GHGs have on public health and welfare both for current and future generations. These assessments include:

- U.S. Global Change Research Program's (USGCRP) 2016 Climate and Health Assessment and 2017–2018 Fourth National Climate Assessment (NCA4) (USGCRP 2016, 2017, 2018).
- IPCC's 2018 Global Warming of 1.5 °C, 2019 Climate Change and Land, and the 2019 Ocean and Cryosphere in a Changing Climate assessments, as well as the 2021 IPCC Sixth Assessment Report (AR6) (IPCC 2018, 2019a, 2019b, 2021).

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[40] See EPA's November 2021 Proposed Standards of Performance for New, Reconstructed, and Modified Sourcesand Emissions Guidelines for Existing Sources: Oil and Natural Gas Sector Climate Review (https://www.govinfo.gov/content/pkg/FR-2021-11-15/pdf/2021-24202.pdf) for more discussion of specific examples. An additional resource for indicators can be found at https://www.epa.gov/climate-indicators.

[41] For example, "[f]ield evidence shows that anthropogenic climate change has increased the area burned by wildfire above natural levels in western North America from 1984-2017 by double for the Western USA…(*high confidence*)" (IPCC (2022a), p. 2-5).

[42] U.S. Global Change Research Program (USGCRP). 2018. Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, 1515 pp. doi: 10.7930/NCA4.2018.

- The National Academies of Sciences, Engineering, and Medicine's 2016 Attribution of Extreme Weather Events in the Context of Climate Change, 2017 Valuing Climate Damages: Updating Estimation of the Social Cost of Carbon Dioxide, and 2019 Climate Change and Ecosystems assessments (NAS 2016, 2017, 2019).
- National Oceanic and Atmospheric Administration's (NOAA) annual State of the Climate reports published by the Bulletin of the American Meteorological Society, most recently in August of 2020 (Blunden and Arndt 2020).
- EPA Climate Change and Social Vulnerability in the United States: A Focus on Six Impacts (2021) (U.S. EPA, 2021).

Net climate benefits (disbenefits) from reducing (increasing) emissions of $CO_2$ can be monetized using estimates of the social cost of carbon (SC-$CO_2$). The SC-$CO_2$ is the monetary value of the net harm to society associated with a marginal increase in $CO_2$ emissions in a given year, or the benefit of avoiding that increase. In principle, SC-$CO_2$ includes the value of all climate change impacts (both negative and positive), including (but not limited to) changes in net agricultural productivity, human health effects, property damage from increased flood risk, natural disasters, disruption of energy systems, risk of conflict, environmental migration, and the value of ecosystem services. The SC-$CO_2$, therefore, should reflect the societal value of reducing (or increasing) emissions of the gas in question by one metric ton. The SC-$CO_2$ is an estimate of the marginal benefit of $CO_2$ abatement along the baseline and the theoretically appropriate value to use in conducting benefit-cost analyses of policies that affect $CO_2$ emissions. In practice, data and modeling limitations naturally restrain the ability of SC-$CO_2$ estimates to include all of the important physical, ecological, and economic impacts of climate change, such that the estimates are a partial accounting of climate change impacts and will therefore, tend to be underestimates of the marginal benefits of abatement.

EPA and other federal agencies began regularly incorporating SC-$CO_2$ estimates in benefit-cost analyses conducted under Executive Order (E.O.) 12866[43] in 2008, following a court ruling in which an agency was ordered to consider the value of reducing $CO_2$ emissions in a rulemaking process. Specifically, the U.S. Ninth Circuit Court of Appeals remanded a fuel economy rule to DOT for failing to monetize $CO_2$ emission reductions, stating that "while the

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[43] Under E.O. 12866, agencies are required, to the extent permitted by law and where applicable, "to assess both the costs and the benefits of the intended regulation and, recognizing that some costs and benefits are difficult to quantify, propose or adopt a regulation only upon a reasoned determination that the benefits of the intended regulation justify its costs." Some statutes also require agencies to conduct at least some of the same analyses required under E.O. 12866, such as the Energy Policy and Conservation Act, which mandates the setting of fuel economy regulations.

record shows that there is a range of values, the value of carbon emissions reduction is certainly not zero."[44]

The SC-GHG estimates presented in the February 2021 SC-GHG TSD and used in this RIA were developed over many years, using a transparent process, peer-reviewed methodologies, the best science available at the time of that process, and with input from the public. Specifically, in 2009, an interagency working group (IWG) that included the EPA and other executive branch agencies and offices was established to develop estimates relying on the best available science for agencies to use. The IWG published SC-$CO_2$ estimates in 2010 that were developed from an ensemble of three widely cited integrated assessment models (IAMs) that estimate global climate damages using highly aggregated representations of climate processes and the global economy combined into a single modeling framework. The three IAMs were run using a common set of input assumptions in each model for future population, economic, and $CO_2$ emissions growth, as well as equilibrium climate sensitivity (ECS) – a measure of the globally averaged temperature response to increased atmospheric $CO_2$ concentrations. These estimates were updated in 2013 based on new versions of each IAM.[45] In August 2016 the IWG published estimates of the social cost of methane (SC-$CH_4$) and nitrous oxide (SC-$N_2O$) using methodologies that are consistent with the methodology underlying the SC-$CO_2$ estimates. The modeling approach that extends the IWG SC-$CO_2$ methodology to non-$CO_2$ GHGs has undergone multiple stages of peer review. The SC-$CH_4$ and SC-$N_2O$ estimates were developed by Marten et al. (2015) and underwent a standard double-blind peer review process prior to journal publication. These estimates were applied in RIAs of EPA proposed rulemakings with $CH_4$ and $N_2O$ emissions impacts.[46] The EPA also sought additional external peer review of technical issues associated with its application to regulatory analysis. Following the completion of the independent external peer review of the application of the Marten et al. (2015) estimates, the EPA began using the estimates in the primary benefit-cost analysis calculations and tables for a number of proposed rulemakings (U.S. EPA, 2015c, 2015d). The

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[44] Ctr. for Biological Diversity v. Nat'l Highway Traffic Safety Admin., 538 F.3d 1172, 1200 (9th Cir. 2008).

[45] Dynamic Integrated Climate and Economy (DICE) 2010 (Nordhaus, 2010), Climate Framework for Uncertainty, Negotiation, and Distribution (FUND) 3.8 (Anthoff and Tol, 2013a, 2013b), and Policy Analysis of the Greenhouse Gas Effect (PAGE) 2009 (Hope, 2013).

[46] The SC-$CH_4$ and SC-$N_2O$ estimates were first used in sensitivity analysis for the Proposed Rulemaking for Greenhouse Gas Emissions and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles–Phase 2 (U.S. EPA, ).

EPA considered and responded to public comments received for the proposed rulemakings before using the estimates in final regulatory analyses in 2016.[47] In 2015, as part of the response to public comments received to a 2013 solicitation for comments on the SC-$CO_2$ estimates, the IWG announced a National Academies of Sciences, Engineering, and Medicine review of the SC-$CO_2$ estimates to offer advice on how to approach future updates to ensure that the estimates continue to reflect the best available science and methodologies. In January 2017, the National Academies released their final report, Valuing Climate Damages: Updating Estimation of the Social Cost of Carbon Dioxide (National Academies, 2017), and recommended specific criteria for future updates to the SC-$CO_2$ estimates, a modeling framework to satisfy the specified criteria, and both near-term updates and longer-term research needs pertaining to various components of the estimation process (National Academies 2017). Shortly thereafter, in March 2017, President Trump issued E.O. 13783, which disbanded the IWG, withdrew the previous SC-GHG TSDs, and directed agencies to ensure SC-GHG estimates used in regulatory analyses are consistent with the guidance contained in OMB's Circular A-4, "including with respect to the consideration of domestic versus international impacts and the consideration of appropriate discount rates" (E.O. 13783, Section 5(c)). Benefit-cost analyses following E.O. 13783 used SC-$CO_2$ estimates that attempted to focus on the specific share of climate change damages in the U.S. as captured by the models (which did not reflect many pathways by which climate impacts affect the welfare of U.S. citizens and residents) and were calculated using two default discount rates recommended by Circular A-4, 3 percent and 7 percent.[48] All other methodological decisions and model versions used in SC-$CO_2$ calculations remained the same as those used by the IWG in 2010 and 2013, respectively.

On January 20, 2021, President Biden issued E.O. 13990, which re-established an IWG and directed it to develop an update of the SC-$CO_2$ estimates that reflect the best available

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[47] See IWG (2016b) for more discussion of the SC-$CH_4$ and SC-$N_2O$ and the peer review and public comment processes accompanying their development.

[48] The EPA regulatory analyses under E.O. 13783 included sensitivity analyses based on global SC-GHG values and using a lower discount rate of 2.5 percent. OMB Circular A-4 (OMB, 2003) recognizes that special considerations arise when applying discount rates if intergenerational effects are important. In the IWG's 2015 Response to Comments, OMB—as a co-chair of the IWG—made clear that "Circular A-4 is a living document," that "the use of 7 percent is not considered appropriate for intergenerational discounting," and that "[t]here is wide support for this view in the academic literature, and it is recognized in Circular A-4 itself." OMB, as part of the IWG, similarly repeatedly confirmed that "a focus on global SCC estimates in [regulatory impact analyses] is appropriate" (IWG 2015).

science and the recommendations of the National Academies. In February 2021, the IWG recommended the interim use of the most recent SC- $CO_2$ estimates developed by the IWG prior to the group being disbanded in 2017, adjusted for inflation (IWG, 2021). As discussed in the February 2021 SC-GHG TSD, the IWG's selection of these interim estimates reflected the immediate need to have SC-$CO_2$ estimates available for agencies to use in regulatory benefit-cost analyses and other applications that were developed using a transparent process, peer reviewed methodologies, and the science available at the time of that process.

As noted above, the EPA participated in the IWG but has also independently evaluated the interim SC-$CO_2$ estimates published in the February 2021 SC-GHG TSD and determined they are appropriate to use to estimate climate benefits for this action. The EPA and other agencies intend to undertake a fuller update of the SC-$CO_2$ estimates that takes into consideration the advice of the National Academies (2017) and other recent scientific literature. The EPA has also evaluated the supporting rationale of the February 2021 SC-GHG TSD, including the studies and methodological issues discussed therein, and concludes that it agrees with the rationale for these estimates presented in the SC-GHG TSD and summarized below.

In particular, the IWG found that the SC-$CO_2$ estimates used under E.O. 13783 fail to reflect the full impact of GHG emissions in multiple ways. First, the IWG concluded that those estimates fail to capture many climate impacts that can affect the welfare of U.S. citizens and residents. Examples of affected interests include direct effects on U.S. citizens and assets located abroad, international trade, and tourism, and spillover pathways such as economic and political destabilization and global migration that can lead to adverse impacts on U.S. national security, public health, and humanitarian concerns. Those impacts are better captured within global measures of the SC-GHGs.

In addition, assessing the benefits of U.S. GHG mitigation activities requires consideration of how those actions may affect mitigation activities by other countries, as those international mitigation actions will provide a benefit to U.S. citizens and residents by mitigating climate impacts that affect U.S. citizens and residents. A wide range of scientific and economic experts have emphasized the issue of reciprocity as support for considering global damages of GHG emissions. Using a global estimate of damages in U.S. analyses of regulatory actions allows the U.S. to continue to actively encourage other nations, including emerging major economies, to take significant steps to reduce emissions. The only way to achieve an efficient allocation of resources for emissions reduction on a global basis—and so benefit the U.S. and its citizens—is for all countries to base their policies on global estimates of damages.

As a member of the IWG involved in the development of the February 2021 SC-GHG TSD, the EPA agrees with this assessment and, therefore, in this proposed rule the EPA centers attention on a global measure of SC-$CO_2$. This approach is the same as that taken in EPA regulatory analyses over 2009 through 2016. A robust estimate of climate damages only to U.S. citizens and residents that accounts for the myriad of ways that global climate change reduces the net welfare of U.S. populations does not currently exist in the literature. As explained in the February 2021 SC-GHG TSD, existing estimates are both incomplete and an underestimate of total damages that accrue to the citizens and residents of the U.S. because they do not fully capture the regional interactions and spillovers discussed above, nor do they include all of the important physical, ecological, and economic impacts of climate change recognized in the climate change literature, as discussed further below. The EPA, as a member of the IWG, will continue to review developments in the literature, including more robust methodologies for estimating the magnitude of the various damages to U.S. populations from climate impacts and reciprocal international mitigation activities, and explore ways to better inform the public of the full range of carbon impacts.

Second, the IWG concluded 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-$CO_2$. Consistent with the findings of the National Academies (2017) and the economic literature, the IWG continued to conclude that the consumption rate of interest is the theoretically appropriate discount rate in an intergenerational context (IWG, 2016b) (IWG, 2010, 2013, 2016a) and recommended that discount rate uncertainty and relevant aspects of intergenerational ethical considerations be accounted for in selecting future discount rates.[49]

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[49] GHG emissions are stock pollutants, where damages are associated with what has accumulated in the atmosphere over time, and they are long lived such that subsequent damages resulting from emissions today occur over many decades or centuries depending on the specific GHG under consideration. In calculating the SC-GHG, the stream of future damages to agriculture, human health, and other market and non-market sectors from an additional unit of emissions are estimated in terms of reduced consumption (or consumption equivalents). Then that stream of future damages is discounted to its present value in the year when the additional unit of emissions was released.

Furthermore, the damage estimates developed for use in the SC-GHG are estimated in consumption-equivalent terms, and so an application of OMB Circular A-4's guidance for regulatory analysis would then use the consumption discount rate to calculate the SC-GHG. The EPA agrees with this assessment and will continue to follow developments in the literature pertaining to this issue. The EPA also notes that while OMB Circular A-4, as published in 2003, recommends using 3 percent and 7 percent discount rates as “default” values, Circular A-4 also reminds agencies that "different regulations may call for different emphases in the analysis, depending on the nature and complexity of the regulatory issues and the sensitivity of the benefit and cost estimates to the key assumptions.” On discounting, Circular A-4 recognizes that “special ethical considerations arise when comparing benefits and costs across generations,” and Circular A-4 acknowledges that analyses may appropriately “discount future costs and consumption benefits…at a lower rate than for intragenerational analysis.” In the 2015 Response to Comments on the Social Cost of Carbon for Regulatory Impact Analysis, OMB, EPA, and the other IWG members recognized that "Circular A-4 is a living document" and “the use of 7 percent is not considered appropriate for intergenerational discounting. There is wide support for this view in the academic literature, and it is recognized in Circular A-4 itself.” Thus, the EPA concludes that a 7 percent discount rate is not appropriate to apply to value the SC-GHGs in the analysis presented in this RIA. In this analysis, to calculate the present and annualized values of climate benefits, the EPA uses the same discount rate as the rate used to discount the value of damages from future GHG emissions, for internal consistency. That approach to discounting follows the same approach that the February 2021 SC-GHG TSD recommends “to ensure internal consistency—i.e., future damages from climate change using the SC-GHG at 2.5 percent should be discounted to the base year of the analysis using the same 2.5 percent rate.” EPA has also consulted the National Academies' 2017 recommendations on how SC-GHG estimates can “be combined in RIAs with other cost and benefits estimates that may use different discount rates.” The National Academies reviewed “several options,” including “presenting all discount rate combinations of other costs and benefits with [SC-GHG] estimates.”

While the IWG works to assess how best to incorporate the latest, peer reviewed science to develop an updated set of SC-GHG estimates, it recommended the interim estimates to be the

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Given the long time horizon over which the damages are expected to occur, the discount rate has a large influence on the present value of future damages.

most recent estimates developed by the IWG prior to the group being disbanded in 2017. The estimates rely on the same models and harmonized inputs and are calculated using a range of discount rates. As explained in the February 2021 SC-GHG TSD, the IWG has concluded that it is appropriate for agencies to revert to the same set of four values drawn from the SC-GHG distributions based on three discount rates as were used in regulatory analyses between 2010 and 2016 and subject to public comment. For each discount rate, the IWG combined the distributions across models and socioeconomic emissions scenarios (applying equal weight to each) and then selected a set of four values for use in agency analyses: an average value resulting from the model runs for each of three discount rates (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. As explained in the February 2021 SC-GHG TSD, this update reflects the immediate need to have an operational SC-GHG that was developed using a transparent process, peer-reviewed methodologies, and the science available at the time of that process. Those estimates were subject to public comment in the context of dozens of proposed rulemakings as well as in a dedicated public comment period in 2013.

Table 4-10 summarizes the interim global SC-$CO_2$ estimates for the years 2027 to 2041. These estimates are reported in 2021$ but are otherwise identical to those presented in the IWG's 2016 TSD (IWG 2016a). For purposes of capturing uncertainty around the SC-$CO_2$ estimates in analyses, the IWG's February 2021 TSD emphasizes the importance of considering all four of the SC-$CO_2$ values. The SC-$CO_2$ increases over time within the models – i.e., the societal harm from one metric ton emitted in 2041 is higher than the harm caused by one metric ton emitted in 2027 – because future emissions produce larger incremental damages as physical and economic systems become more stressed in response to greater climatic change, and because GDP is growing over time and many damage categories are modeled as proportional to GDP.

**Table 4-10: Interim Global Social Cost of Carbon Values, 2027-2041 (2021$/Metric Ton $CO_2$)**

| Year | Discount Rate and Statistic | | | |
|---|---|---|---|---|
| | 5% Average | 3% Average | 2.50% Average | 3% 95th Percentile |
| **2027** | $19 | $61 | $90 | $180 |
| **2028** | $19 | $62 | $91 | $190 |
| **2029** | $20 | $63 | $92 | $190 |
| **2030** | $20 | $65 | $94 | $200 |
| **2031** | $21 | $66 | $95 | $200 |
| **2032** | $21 | $67 | $96 | $200 |
| **2033** | $22 | $68 | $98 | $210 |
| **2034** | $23 | $69 | $99 | $210 |
| **2035** | $23 | $71 | $100 | $220 |
| **2036** | $24 | $72 | $100 | $220 |
| **2037** | $25 | $73 | $100 | $220 |
| **2038** | $25 | $74 | $110 | $230 |
| **2039** | $26 | $75 | $110 | $230 |
| **2040** | $26 | $77 | $110 | $240 |
| **2041** | $27 | $78 | $110 | $240 |

Note: These SC-$CO_2$ values are identical to those reported in the 2016 TSD (IWG 2016a, cited in footnote 43 above) adjusted for inflation to 2021$ using the annual GDP Implicit Price Deflator values in the U.S. Bureau of Economic Analysis' (BEA) NIPA Table 1.1.9 found at https://fred.stlouisfed.org/release/tables?rid=53&eid=41158. The values are stated in $/metric ton $CO_2$ (1 metric ton equals 1.102 short tons) and vary depending on the year of $CO_2$ emissions. This table displays the values rounded to the nearest dollar; the annual unrounded values used in the calculations in this RIA are available on OMB's website: <https://www.whitehouse.gov/briefing-room/blog/2021/02/26/a-return-to-science-evidence-based-estimates-of-the-benefits-of-reducing-climate-pollution/>.
Source: https://www.whitehouse.gov/briefing-room/blog/2021/02/26/a-return-to-science-evidence-based-estimates-of-the-benefits-of-reducing-climate-pollution/

There are a number of limitations and uncertainties associated with the SC-$CO_2$ estimates presented in Table 4-10. Some uncertainties are captured within the analysis, while other areas of uncertainty have not yet been quantified in a way that can be modeled. **Error! Reference source not found.** Figure 4-1 presents the quantified sources of uncertainty in the form of frequency distributions for the SC-$CO_2$ estimates for emissions in 2030. The distributions of SC-$CO_2$ estimates reflect uncertainty in key model parameters such as the equilibrium climate sensitivity, as well as uncertainty in other parameters set by the original model developers. To highlight the difference between the impact of the discount rate and other quantified sources of uncertainty, the bars below the frequency distributions provide a symmetric representation of quantified variability in the SC-$CO_2$ estimates for each discount rate. As illustrated by the figure, the assumed discount rate plays a critical role in the ultimate estimate of the SC-$CO_2$. This is because $CO_2$ emissions today continue to impact society far out into the future, so with a higher discount rate, costs that accrue to future generations are weighted less, resulting in a lower estimate. As discussed in the February 2021 TSD, there are other sources of uncertainty that have not yet been quantified and are thus not reflected in these estimates.

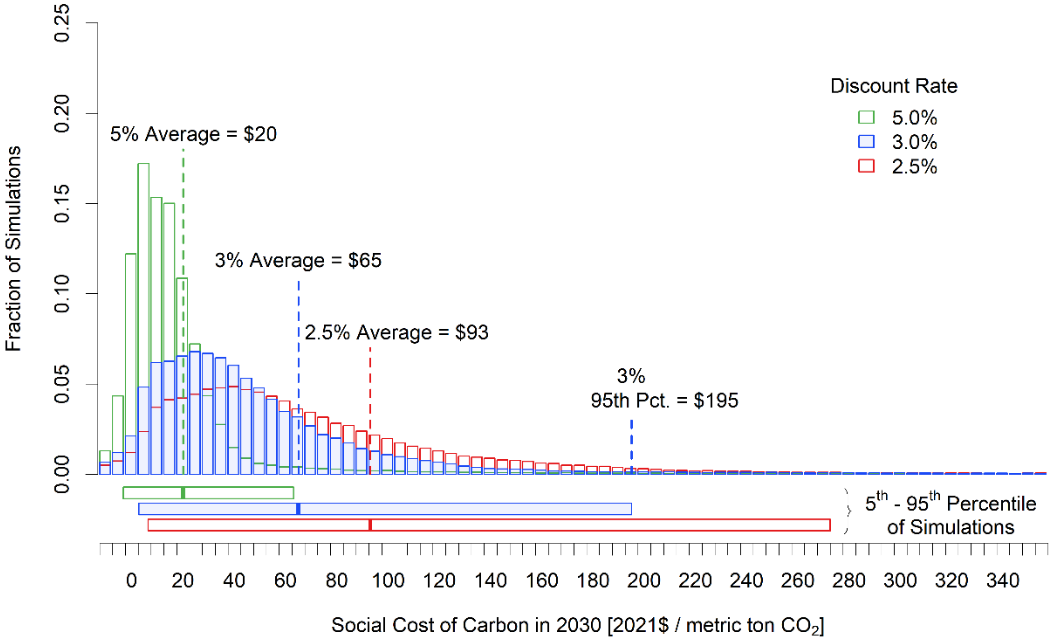

**Figure 4 1: Frequency Distribution of SC-CO2 Estimates for 2030**

The interim SC-$CO_2$ estimates presented in Table 4-10 have a number of other limitations. First, the current scientific and economic understanding of discounting approaches suggests discount rates appropriate for intergenerational analysis in the context of climate change are likely to be less than 3 percent, near 2 percent or lower (IWG 2021). Second, the IAMs used to produce these 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 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. Likewise, the socioeconomic and emissions scenarios used as inputs to the models do not reflect new information from the last decade of scenario generation or the full range of projections.

The modeling limitations do not all work in the same direction in terms of their influence on the SC-$CO_2$ estimates. However, as discussed in the February 2021 TSD, the IWG has recommended that, taken together, the limitations suggest that the interim SC-$CO_2$ estimates used in this final action likely underestimate the damages from $CO_2$ emissions. EPA concurs that the values used in this action conservatively underestimate the action's climate disbenefits. In particular, the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (IPCC 2007), which was the most current IPCC assessment available at the time when the IWG decision over the ECS input was made, concluded that SC-$CO_2$ estimates "very likely…underestimate the damage costs" due to omitted impacts. Since then, the peer-reviewed literature has continued to support this conclusion, as noted in the IPCC's Fifth Assessment report (IPCC 2014) and other recent scientific assessments (e.g., IPCC (2018, 2019a, 2019b)); U.S. Global Change Research Program (USGCRP, 2016, 2018); and the National Academies of Sciences, Engineering, and Medicine (National Academies, 2017, 2019).

These assessments confirm and strengthen the science, updating projections of future climate change and documenting and attributing ongoing changes. For example, sea level rise projections from the IPCC's Fourth Assessment report ranged from 18 to 59 centimeters by the 2090s relative to 1980-1999, while excluding any dynamic changes in ice sheets due to the limited understanding of those processes at the time (IPCC 2007). A decade later, the Fourth National Climate Assessment projected a substantially larger sea level rise of 30 to 130 centimeters by the end of the century relative to 2000, while not ruling out even more extreme outcomes (USGCRP 2018).

The February 2021 SC-GHG TSD briefly previews some of the recent advances in the scientific and economic literature that the IWG is actively following and that could provide guidance on, or methodologies for, addressing some of the limitations with the interim SC-GHG estimates. The IWG is currently working on a comprehensive update of the SC-GHG estimates taking into consideration recommendations from the National Academies of Sciences, Engineering and Medicine, recent scientific literature, public comments received on the February

2021 SC-GHG TSD and other input from experts and diverse stakeholder groups (National Academies 2017). While that process continues, the 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 has published an updated SC-GHG methodology in the regulatory impact analysis of EPA's December 2023 final rulemaking for oil and gas standards that reflects recent advances in the climate science and economics (U.S. EPA, 2023e). Specifically, the 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. The EPA solicited public comment on these estimates and the accompanying draft technical report, which explains the methodology underlying the new set of estimates, in the docket for the November 2022 supplemental proposed Oil and Gas rule. The EPA also conducted an external peer review of the technical report. The final technical report (U.S. EPA 2023f) and more information about the peer review and public comments is available on EPA's website.[50] As the updated SC-GHG values were still draft at the time this analysis was conducted, EPA did not use them in the main analysis for this RIA to monetize the estimated climate disbenefits of this final rule but they are noted below.

Table 4-11 through Table 4-14 show the monetized climate disbenefits from changes in $CO_2$ emissions expected to occur for the final action from 2027 to 2041 from Table 3-16. For each year, EPA estimated the dollar value of the $CO_2$-related effects by applying the SC-$CO_2$ estimates, shown in Table 4-10, to the estimated changes in $CO_2$ emissions in the corresponding year under the final action.[51] EPA calculated the present value (PV) and equivalent annualized

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[50] See https://www.epa.gov/environmental-economics/scghg

[51] $CO_2$ emissions increases above the baseline as a result of the modeled policy are first expected in 2027, as control technologies applied in response to the final rule first begin operation in that year, and those emissions increases are expected to remain at that level afterwards, according to the cost analysis for this rule.

value of disbenefits (EAV) from the perspective of 2024 by discounting each year-specific value to the year 2024 using the same discount rate used to calculate the SC-$CO_2$.[52]

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[52] According to OMB's Circular A-4 (2003), an "analysis should focus on benefits and costs that accrue to citizens and residents of the United States", and international effects should be reported separately. Circular A-4 also reminds analysts that "[d]ifferent regulations may call for different emphases in the analysis, depending on the nature and complexity of the regulatory issues." To correctly assess the total climate damages to U.S. citizens and residents, an analysis must account for impacts that occur within U.S. borders, climate impacts occurring outside U.S. borders that directly and indirectly affect the welfare of U.S. citizens and residents, how U.S. GHG mitigation activities affect mitigation activities by other countries, and spillover effects from climate action elsewhere. The SC-GHG estimates used in regulatory analysis under revoked E.O. 13783 were an approximation of the climate damages occurring within U.S. borders only (e.g., \$8/mt$CO_2$ (2021\$) in 2027 and for year 2041 \$10/mt$CO_2$ in 2041 using a 3% discount rate for emissions occurring in 2025). Applying the same estimate (based on a 3% discount rate) to the $CO_2$ emission reduction expected under the final option in this final rule would yield disbenefits from climate impacts within U.S borders of \$0.2 to \$0.3 million (2021\$).  However, as discussed at length in the February 2021 TSD, estimates focusing on the climate impacts occurring solely within U.S. borders are an underestimate of the benefits of $CO_2$ mitigation accruing to U.S. citizens and residents, as well as being subject to a considerable degree of uncertainty due to the manner in which they are derived. In particular, the estimates developed under revoked E.O. 13783 did not capture significant regional interactions, spillovers, and other effects and so are incomplete underestimates. The U.S. District Court for the Northern District of California found that by omitting such impacts, those "interim domestic" estimates "fail[ed] to consider…important aspect[s] of the problem" and departed from the "best science available" as reflected in the global estimates. California v. Bernhardt, 472 F. Supp. 3d 573, 613-14 (N.D. Cal. 2020). EPA continues to center attention in this regulatory analysis on the global measures of the SC-GHG as the appropriate estimates and as necessary for all countries to use to achieve an efficient allocation of resources for emissions reduction on a global basis, and so benefit the U.S. and its citizens.

## Table 4-11: Discounted Monetized Climate Disbenefits under the Final Amendments, GACT 6B, 2027-2041 (millions 2021$)

| Year | Discounted back to 2024<br>5% Average | <br>3% Average | <br>2.50% Average | <br>3% 95th Percentile |
|---|---|---|---|---|
| **2027** | $0.5 | $1.8 | $2.6 | $5.3 |
| **2028** | $0.5 | $1.8 | $2.6 | $5.4 |
| **2029** | $0.5 | $1.8 | $2.6 | $5.5 |
| **2030** | $0.4 | $1.9 | $2.7 | $5.6 |
| **2031** | $0.4 | $1.9 | $2.7 | $5.7 |
| **2032** | $0.4 | $1.9 | $2.8 | $5.8 |
| **2033** | $0.4 | $2.0 | $2.8 | $5.9 |
| **2034** | $0.4 | $2.0 | $2.8 | $6.0 |
| **2035** | $0.4 | $2.0 | $2.9 | $6.1 |
| **2036** | $0.4 | $2.1 | $2.9 | $6.3 |
| **2037** | $0.4 | $2.1 | $3.0 | $6.4 |
| **2038** | $0.4 | $2.1 | $3.0 | $6.5 |
| **2039** | $0.4 | $2.2 | $3.1 | $6.6 |
| **2040** | $0.4 | $2.2 | $3.1 | $6.7 |
| **2041** | $0.3 | $2.3 | $3.1 | $6.8 |
| **PV** | **$6.1** | **$30** | **$43** | **$91** |
| **EAV** | **$0.6** | **$2.5** | **$3.5** | **$7.6** |

Note: Climate disbenefits are based on changes (reductions) in $CO_2$ emissions and are calculated using four different estimates of the social cost of carbon (SC-$CO_2$) (model average at constant 2.5 percent, 3 percent, and 5 percent discount rates; 95th percentile at 3 percent discount rate) presented in the Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under Executive Order 13990 (IWG 2021). Using the updated SC-$CO_2$ estimates that were presented in the RIA for EPA's December 2023 final rulemaking on oil and natural gas sector sources (U.S. EPA 2023), the PV and EAV of monetized climate disbenefits under the Final Amendments, GACT 6B, is estimated to be $90 million and $6 million (under the 2% near-term Ramsey discount rate), respectively.

**Table 4-12: Discounted Monetized Climate Disbenefits under the Final Amendments, NSPS XX, 2027-2041 (millions 2021$)**

| | Discounted back to 2024 | | | |
|---|---|---|---|---|
| **Year** | **5% Average** | **3% Average** | **2.50% Average** | **3% 95th Percentile** |
| **2027** | $0.03 | $0.12 | $0.17 | $0.35 |
| **2028** | $0.04 | $0.14 | $0.21 | $0.42 |
| **2029** | $0.04 | $0.17 | $0.24 | $0.50 |
| **2030** | $0.05 | $0.20 | $0.28 | $0.59 |
| **2031** | $0.05 | $0.22 | $0.32 | $0.68 |
| **2032** | $0.06 | $0.25 | $0.36 | $0.77 |
| **2033** | $0.06 | $0.29 | $0.41 | $0.86 |
| **2034** | $0.06 | $0.32 | $0.45 | $0.95 |
| **2035** | $0.07 | $0.35 | $0.50 | $1.05 |
| **2036** | $0.07 | $0.38 | $0.54 | $1.16 |
| **2037** | $0.08 | $0.42 | $0.59 | $1.26 |
| **2038** | $0.08 | $0.45 | $0.64 | $1.37 |
| **2039** | $0.08 | $0.49 | $0.68 | $1.48 |
| **2040** | $0.08 | $0.53 | $0.73 | $1.59 |
| **2041** | $0.09 | $0.57 | $0.78 | $1.71 |
| **PV** | **$0.94** | **$4.9** | **$6.9** | **$14.7** |
| **EAV** | **$0.09** | **$0.41** | **$0.56** | **$1.23** |

Note: Climate disbenefits are based on changes (reductions) in $CO_2$ emissions and are calculated using four different estimates of the social cost of carbon (SC-$CO_2$) (model average at constant 2.5 percent, 3 percent, and 5 percent discount rates; 95th percentile at 3 percent discount rate) presented in the Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under Executive Order 13990 (IWG 2021). Using the updated SC-$CO_2$ estimates that were presented in the RIA for EPA's December 2023 final rulemaking on oil and natural gas sector sources (U.S. EPA 2023), the PV and EAV of monetized climate disbenefits under the Final Amendments, NSPS XX, is estimated to be $14 million and $1 million (under the 2% near-term Ramsey discount rate), respectively.

## Table 4-13: Discounted Monetized Climate Disbenefits under the Final Amendments, NSPS XX, MACT R, GACT 6B, 2027-2041 (millions, 2021$)

| | Discounted back to 2024 | | | |
|---|---|---|---|---|
| **Year** | **5%**<br>**Average** | **3%**<br>**Average** | **2.50%**<br>**Average** | **3%**<br>**95th Percentile** |
| **2027** | $0.5 | $1.9 | $2.7 | $5.6 |
| **2028** | $0.5 | $1.9 | $2.8 | $5.8 |
| **2029** | $0.5 | $2.0 | $2.9 | $6.0 |
| **2030** | $0.5 | $2.1 | $3.0 | $6.2 |
| **2031** | $0.5 | $2.1 | $3.0 | $6.4 |
| **2032** | $0.5 | $2.2 | $3.1 | $6.6 |
| **2033** | $0.5 | $2.3 | $3.2 | $6.8 |
| **2034** | $0.5 | $2.3 | $3.3 | $7.0 |
| **2035** | $0.5 | $2.4 | $3.4 | $7.2 |
| **2036** | $0.5 | $2.5 | $3.5 | $7.4 |
| **2037** | $0.5 | $2.5 | $3.6 | $7.6 |
| **2038** | $0.5 | $2.6 | $3.6 | $7.9 |
| **2039** | $0.4 | $2.7 | $3.7 | $8.1 |
| **2040** | $0.4 | $2.7 | $3.8 | $8.3 |
| **2041** | $0.4 | $2.8 | $3.9 | $8.5 |
| **PV** | **$7.1** | **$35** | **$50** | **$105** |
| **EAV** | **$0.7** | **$2.9** | **$4.0** | **$8.8** |

Note: Climate disbenefits are based on changes (reductions) in $CO_2$ emissions and are calculated using four different estimates of the social cost of carbon (SC-$CO_2$) (model average at constant 2.5 percent, 3 percent, and 5 percent discount rates; 95th percentile at 3 percent discount rate) presented in the Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under Executive Order 13990 (IWG 2021). Using the updated SC-$CO_2$ estimates that were presented in the RIA for EPA's December 2023 final rulemaking on oil and natural gas sector sources (U.S. EPA 2023), the PV and EAV of monetized climate disbenefits under the Final Amendments (NSPS XX, MACT R, and GACT 6B) is estimated to be $100 million and $7 million (under the 2% near-term Ramsey discount rate), respectively.

**Table 4-14: Undiscounted Monetized Climate Disbenefits under Proposed Amendments, NSPS XX, MACT R, GACT 6B, 2027-2041 (millions, 2021$)**

| | Undiscounted | | | |
|---|---|---|---|---|
| Year | 5% Average | 3% Average | 2.50% Average | 3% 95th Percentile |
| **2027** | $0.6 | $1.9 | $2.8 | $5.8 |
| **2028** | $0.6 | $2.0 | $2.9 | $6.0 |
| **2029** | $0.6 | $2.0 | $3.0 | $6.2 |
| **2030** | $0.7 | $2.1 | $3.0 | $6.3 |
| **2031** | $0.7 | $2.2 | $3.1 | $6.6 |
| **2032** | $0.7 | $2.2 | $3.2 | $6.8 |
| **2033** | $0.7 | $2.3 | $3.3 | $7.0 |
| **2034** | $0.8 | $2.4 | $3.4 | $7.2 |
| **2035** | $0.8 | $2.4 | $3.5 | $7.4 |
| **2036** | $0.8 | $2.5 | $3.6 | $7.6 |
| **2037** | $0.9 | $2.6 | $3.6 | $7.9 |
| **2038** | $0.9 | $2.6 | $3.7 | $8.1 |
| **2039** | $0.9 | $2.7 | $3.8 | $8.3 |
| **2040** | $1.0 | $2.8 | $3.9 | $8.6 |
| **2041** | $1.0 | $2.9 | $4.0 | $8.8 |

Note: Climate disbenefits are based on changes (reductions) in $CO_2$ emissions and are calculated using four different estimates of the social cost of carbon (SC-$CO_2$) (model average at constant 2.5 percent, 3 percent, and 5 percent discount rates; 95th percentile at 3 percent discount rate) presented in the Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under Executive Order 13990 (IWG 2021).

The climate disbenefits associated with the additional $CO_2$ emissions generated as a result of the requirements of the final action are therefore $35 million in 2024 PV ($2.9 million EAV) at a 3 percent discount rate, and range from $7.1 million PV ($0.7 million EAV) at a 5 percent discount rate to $105 million PV ($8.8 million EAV) at a 3 percent discount rate (95th percentile), all in 2021$.[53] These disbenefits are estimated for 2027-2041, 15 years starting from the first year of full implementation of both GACT 6B and NSPS XX (3 years after the effective date) using the interim global social cost of carbon (SC-$CO_2$) for 2027-2041 as shown in Table 4-10.[54], , The climate disbenefits are less than 7 percent of the monetized long-term health

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[53] In order to calculate these values, it is necessary to convert tons (short) of emissions to metric tons. These values may be converted to $/short ton using the conversion factor 0.90718474 metric tons per short ton for application to the short ton $CO_2$ emissions impacts provided in this action.

[54] These SC-$CO_2$ values are stated in $/metric ton $CO_2$ and rounded to the nearest dollar. Such a conversion does not change the underlying methodology, nor does it change the meaning of the SC-$CO_2$ estimates. For both metric and short tons denominated SC-$CO_2$ estimates, the estimates vary depending on the year of $CO_2$ emissions and are defined in real terms, i.e., adjusted for inflation using the Gross Domestic Product (GDP) implicit price deflator.

benefits lower bound estimate even at the 3 percent (95th percentile), the discount rate yielding the highest climate disbenefit estimate. At a discount rate of 3 percent (model average), the climate disbenefits are less than 3 percent of the monetized long-term health benefits.  Thus, the monetized climate disbenefits are relatively small when compared to the monetized health benefits.

## 4.7 Total Monetized Benefits

Table 4-15 through Table 4-18 present a summary of monetized benefits for the final amendments to GACT 6B and MACT R, and final NSPS XX both individually and cumulatively. Net benefits in each table are calculated as health benefits minus climate disbenefits. Benefits related to both short- and long-term exposure to ozone are estimated. Tables presenting benefits list both estimates, with short-term benefits listed first. A complete discussion of benefits relative to costs appears in Chapter 6.

**Table 4-15: Summary of Monetized Benefits PV/EAV for GACT 6B, 2027-2041, (million 2021$)**

| | Final | | Less Stringent Alternative | | More Stringent Alternative | |
|---|---|---|---|---|---|---|
| 3% | PV | EAV | PV | EAV | PV | EAV |
| Health Benefits | \$200 and \$1,600 | \$17 and \$140 | \$58 and \$460 | \$4.8 and \$39 | \$250 and \$2,000 | \$21 and \$170 |
| Climate Disbenefits | \$30 | \$2.5 | \$30 | \$2.5 | \$30 | \$2.5 |
| Net Benefits | \$170 and \$1,600 | \$15 and \$140 | \$28 and \$430 | \$2.3 and \$37 | \$220 and \$2,000 | \$19 and \$170 |
| 7% | | | | | | |
| Health Benefits | \$120 and \$980 | \$13 and \$110 | \$34 and \$280 | \$3.7 and \$30 | \$150 and \$1,200 | \$16 and \$130 |
| Climate Disbenefits (3%) | \$30 | \$2.5 | \$30 | \$2.5 | \$30 | \$2.5 |
| Net Benefits | \$90 and \$950 | \$11 and \$110 | \$4.0 and \$250 | \$1.2 and \$28 | \$120 and \$1,200 | \$14 and \$130 |

Note: Monetized benefits include ozone related health benefits associated with reductions in VOC emissions. The health benefits are associated with several point estimates and are presented at real discount rates of 3 and 7 percent s. The two benefits estimates are separated by the word "and" to signify that they are two separate estimates. The estimates do not represent lower- and upper-bound estimates. Benefits from HAP reductions and VOC reductions outside of the ozone season remain unmonetized and are thus not reflected in the table. These non-monetized benefits also include ozone climate impacts and benefits to ecosystem services associated with improvements in biomass loss and foliar injury. The unmonetized effects also include disbenefits resulting from a secondary increase in $NO_2$, $SO_2$, and CO emissions. Climate disbenefits are based on changes (increases) in $CO_2$ emissions and are calculated using four different estimates of the social cost of carbon (SC-$CO_2$) (model average at 2.5 percent, 3 percent, and 5 percent discount rates; 95th percentile at 3 percent discount rate) presented in the Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under Executive Order 13990 (IWG 2021). For the presentational purposes of this table, we show the disbenefits associated with the average SC-$CO_2$ at a 3 percent discount rate. Please see Section 4.6 for more discussion of the climate disbenefits. Rows may not appear to add correctly due to rounding.

**Table 4-16: Summary of Monetized Benefits PV/EAV for MACT R, 2027-2041, (million 2021$)**

| | Final | | Less Stringent Alternative | | More Stringent Alternative | |
|---|---|---|---|---|---|---|
| 3% | PV | EAV | PV | EAV | PV | EAV |
| Health Benefits | $11 and $87 | $0.89 and $7.3 | $2.3 and $19 | $0.19 and $1.6 | $13 and $110 | $1.1 and $9.0 |
| Climate Disbenefits | $0 | $0 | $0 | $0 | $0 | $0 |
| Net Benefits | $11 and $87 | $0.89 and $7.3 | $2.3 and $19 | $0.19 and $1.6 | $13 and $110 | $1.1 and $9.0 |
| 7% | | | | | | |
| Health Benefits | $6.3 and $52 | $0.70 and $5.8 | $1.4 and $11 | $0.15 and $1.2 | $8.0 and $6.5 | $0.87 and $7.2 |
| Climate Disbenefits (3%) | $0 | $0 | $0 | $0 | $0 | $0 |
| Net Benefits | $6.3 and $52 | $0.70 and $5.8 | $1.4 and $11 | $0.15 and $1.2 | $8.0 and $6.5 | $0.87 and $7.2 |

Note: Monetized benefits include ozone related health benefits associated with reductions in VOC emissions. The health benefits are associated with several point estimates and are presented at real discount rates of 3 and 7 percent. The two benefits estimates are separated by the word “and” to signify that they are two separate estimates. The estimates do not represent lower- and upper-bound estimates. Benefits from HAP reductions and VOC reductions outside of the ozone season remain unmonetized and are thus not reflected in the table. These non-monetized benefits also include ozone climate impacts and benefits to ecosystem services associated with improvements in biomass loss and foliar injury. The unmonetized effects also include disbenefits resulting from a secondary increase in $NO_2$, $SO_2$, and CO emissions. Climate disbenefits are based on changes (increases) in $CO_2$ emissions and are calculated using four different estimates of the social cost of carbon (SC-$CO_2$) (model average at 2.5 percent, 3 percent, and 5 percent discount rates; 95th percentile at 3 percent discount rate) presented in the Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under Executive Order 13990 (IWG 2021). For the presentational purposes of this table, we show the disbenefits associated with the average SC-$CO_2$ at a 3 percent discount rate. Please see Section 4.6 for more discussion of the climate disbenefits. Rows may not appear to add correctly due to rounding.

## Table 4-17: Summary of Monetized Benefits PV/EAV for NSPS XXa, 2027-2041, (million 2021$)

| | Final | | Less Stringent Alternative | | More Stringent Alternative | |
|---|---|---|---|---|---|---|
| 3% | PV | EAV | PV | EAV | PV | EAV |
| Health Benefits | $34 and $280 | $2.8 and $24 | $2.8 and $23 | $0.24 and $2.0 | $34 and $280 | $2.8 and $24 |
| Climate Disbenefits | $4.9 | $0.41 | $4.9 | $0.41 | $4.9 | $0.41 |
| Net Benefits | $29 and $280 | $2.4 and $24 | ($2.2) and $18 | ($0.17) and $1.6 | $29 and $280 | $2.4 and $24 |
| 7% | | | | | | |
| Health Benefits | $19 and $160 | $2.1 and $17 | $1.6 and $13 | $0.17 and $1.4 | $19 and $160 | $2.1 and $18 |
| Climate Disbenefits (3%) | $4.9 | $0.41 | $4.9 | $0.41 | $4.9 | $0.41 |
| Net Benefits | $14 and $160 | $1.7 and $17 | ($3.3) and $8.1 | ($0.24) and $0.99 | $14 and $160 | $1.7 and $18 |

Note: Monetized benefits include ozone related health benefits associated with reductions in VOC emissions. The health benefits are associated with several point estimates and are presented at real discount rates of 3 and 7 percent. The two benefits estimates are separated by the word "and" to signify that they are two separate estimates. The estimates do not represent lower- and upper-bound estimates. Benefits from HAP reductions and VOC reductions outside of the ozone season remain unmonetized and are thus not reflected in the table. These non-monetized benefits also include ozone climate impacts and benefits to ecosystem services associated with improvements in biomass loss and foliar injury. The unmonetized effects also include disbenefits resulting from a secondary increase in NO$_2$, SO$_2$, and CO emissions. Climate disbenefits are based on changes (increases) in CO$_2$ emissions and are calculated using four different estimates of the social cost of carbon (SC-CO$_2$) (model average at 2.5 percent, 3 percent, and 5 percent discount rates; 95th percentile at 3 percent discount rate) presented in the Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under Executive Order 13990 (IWG 2021). For the presentational purposes of this table, we show the disbenefits associated with the average SC-CO$_2$ at a 3 percent discount rate. Please see Section 4.6 for more discussion of the climate disbenefits. Rows may not appear to add correctly due to rounding.

**Table 4-18: Summary of Monetized Benefits PV/EAV for All Rules, 2027-2041, (million 2021$)**

| | Final | | Less Stringent Alternative | | More Stringent Alternative | |
|---|---|---|---|---|---|---|
| 3% | PV | EAV | PV | EAV | PV | EAV |
| Health Benefits | $240<br>and<br>$2,000 | $20<br>and<br>$170 | $63<br>and<br>$500 | $5.3<br>and<br>$42 | $290<br>and<br>$2,400 | $25<br>and<br>$200 |
| Climate Disbenefits | $35 | $2.9 | $35 | $2.9 | $35 | $2.9 |
| Net Benefits | $210<br>and<br>$2,000 | $17<br>and<br>$170 | $28<br>and<br>$470 | $2.4<br>and<br>$39 | $260<br>and<br>$2,400 | $22<br>and<br>$200 |
| 7% | | | | | | |
| Health Benefits | $140<br>and<br>$1,200 | $16<br>and<br>$130 | $37<br>and<br>$300 | $4.0<br>and<br>$33 | $180<br>and<br>$1,400 | $19<br>and<br>$160 |
| Climate Disbenefits (3%) | $35 | $2.9 | $35 | $2.9 | $35 | $2.9 |
| Net Benefits | $110<br>and<br>$1,200 | $13<br>and<br>$130 | $2.0<br>and<br>$270 | $1.1<br>and<br>$30 | $150<br>and<br>$1,400 | $16<br>and<br>$160 |

Note: Monetized benefits include ozone related health benefits associated with reductions in VOC emissions. The health benefits are associated with several point estimates and are presented at real discount rates of 3 and 7 percent. The two benefits estimates are separated by the word "and" to signify that they are two separate estimates. The estimates do not represent lower- and upper-bound estimates. Benefits from HAP reductions and VOC reductions outside of the ozone season remain unmonetized and are thus not reflected in the table. These non-monetized benefits also include ozone climate impacts and benefits to ecosystem services associated with improvements in biomass loss and foliar injury. The unmonetized effects also include disbenefits resulting from a secondary increase in $NO_2$, $SO_2$, and CO emissions. Climate disbenefits are based on changes (increases) in $CO_2$ emissions and are calculated using four different estimates of the social cost of carbon (SC-$CO_2$) (model average at 2.5 percent, 3 percent, and 5 percent discount rates; 95th percentile at 3 percent discount rate) presented in the Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under Executive Order 13990 (IWG 2021). For the presentational purposes of this table, we show the disbenefits associated with the average SC-$CO_2$ at a 3 percent discount rate. Please see Section 4.6 for more discussion of the climate disbenefits. Rows may not appear to add correctly due to rounding.

# 5 ECONOMIC IMPACT ANALYSIS AND DISTRIBUTIONAL ASSESSMENTS

## 5.1 Introduction

As discussed in the previous section, the emissions reductions projected under the action are projected to produce up to $170 million per year of monetized VOC health benefits. At the same time, the final amendments to GACT 6B are projected to result in environmental control expenditures by the Gasoline Distribution sector to comply with the rule. The final amendments to the NESHAP for Gasoline Distribution MACT R and the final NSPS for Bulk Gasoline Terminals are significant under E.O. 12866 Section 3(f)(1).

While the national level impacts demonstrate the final action is likely to lead to substantial benefits and costs, the benefit-cost analysis does not speak directly to all potential economic and distributional impacts of the final rules, which may be important consequences of the action. This section includes two sets of economic impact and distributional analyses for each individual rule included in this final action directed toward complementing the benefit-cost analysis. This includes a partial equilibrium analysis of market impacts and an analysis of potentially affected small entities.

## 5.2 Economic Impact Analysis

To provide a measure of the market impacts of the final amendments to the NESHAPs for Gasoline Distribution and final NSPS for Bulk Gasoline Terminals, EPA developed a single-market, static partial equilibrium model of the market for gasoline in the United States. The model does not consider imports or exports of gasoline. This should not materially affect the analysis, as gasoline imports make up a very small portion of total consumption and gasoline exports make up a relatively small portion of total production.[55] The model also does not model linkages between the gasoline market and other energy markets. The goal is to provide broad insights into national-level market impacts and social costs of the final action. The analysis allows for an estimate of how the final regulation will affect the price of gasoline and the

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[55] In 2019, imports of finished gasoline accounted for about 1% of U.S. gasoline consumption. See data from the U.S. Energy Information Administration: <https://www.eia.gov/dnav/pet/pet_move_impcus_a2_nus_epm0f_im0_mbbl_a.htm>. The U.S. is a net exporter of gasoline, with exports accounting for about 8% of U.S. production (<https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=pet&s=mgfexus1&f=a>). Gasoline exports are seasonal increasing during periods of lower U.S. demand (See: <https://www.eia.gov/todayinenergy/detail.php?id=49896>).

quantity of gasoline consumed and identifies how social costs of the final regulation are distributed across consumers and firms. Using the model, it is straightforward to estimate the economic impacts of the amendments to GACT 6B and MACT R and final NSPS XXa both separately and cumulatively. This analytical approach is consistent with the Economic Impact Analysis conducted for the 2008 area source NESHAP (U.S. EPA, 2008), which is the most recent regulatory action taken by EPA to reduce HAP emissions from the gasoline distribution sector.

### 5.2.1 *Description of Approach/Model/Framework*

#### *5.2.1.1 Gasoline Market Model*

EPA used a static, single-market partial equilibrium analysis of a national gasoline market to estimate the economic impacts of the final NESHAP amendments and final NSPS XXa. The analysis builds on the engineering costs analysis presented earlier and uses economic theory related to consumer and producer behavior to estimate changes in market prices, quantities, and economic welfare.

The model assumes perfect competition in the market for gasoline. This assumption was made in the partial-equilibrium analysis conducted for the Economic Impact Analysis of the 2008 area source NESHAP; given little evidence of structural changes in gasoline distribution since 2008, maintaining the assumption is reasonable. Supply and demand for gasoline are isoelastic.[56] The model is defined by the following set of equations:

$$Q_{St} = A_{St} * (p_t - c_{kt})^{\varepsilon_S} \qquad (1)$$

$$Q_{Dt} = A_{Dt} * p_t^{\varepsilon_D} \qquad (2)$$

$$Q_{St} = Q_{Dt} \qquad (3)$$

where $p_t$ is price at time $t$, $\varepsilon_S$ and $\varepsilon_D$ are the elasticity of supply and demand for gasoline, $A_{St}$ and $A_{Dt}$ are supply and demand specific parameters, and $c_{kt}$ is a per-unit cost shifter at time

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[56] This is a simplifying assumption and is justifiable given the small increases to engineering cost on a per-unit basis for each final rule considered in this ERA.

$t$ for regulation $k$. Equations (1) and (2) define the supply and demand curves for gasoline, $Q_{St}$ and $Q_{Dt}$, respectively, and equation (3) defines equilibrium in the gasoline market.

The following steps are necessary to solve the model:

1. Specify values for the elasticity parameters $\varepsilon_S$ and $\varepsilon_D$.
2. Specify baseline values for prices and quantities for all t.
3. Calibrate $A_{St}$ and $A_{Dt}$ by inverting the supply and demand equations given parameter values, given baseline prices and quantities, and assuming $c_{kt} = 0$ in the baseline for all k and t.
4. Calculate $c_{kt}$ for the following policies: NSPS XXa, MACT R, GACT 6B, and "All," where All is the cumulative cost of NSPS XXa, MACT R, and GACT 6B.
5. Solve for equilibrium for each policy and analysis year.

Equilibrium is solved for numerically using the software program GAMS. There is no relationship between solutions in different years. The model can be characterized as a set of single-period partial equilibrium models.

### *5.2.1.2 Model Baseline*

This RIA seeks to compare the state of the market with and without the changes to NSPS XX, MACT R, and GACT 6B in effect. EPA selected the years 2027-2041 as the baseline for the market analysis. These years were chosen for consistency with the engineering cost analysis presented previously. The *Annual Energy Outlook 2023*, compiled by the Energy Information Administration, projects gasoline prices and consumption through 2050, and provides the baseline price and quantity data for the analysis. For an overview of the model, see Table 5-1.

**Table 5-1: Description of Gasoline Market Model**

| | |
|---|---|
| Geographic Scope | National |
| Product Groupings | Single gasoline market |
| Firm/consumer behavior | Perfect competition |
| Baseline gasoline price/quantity | See Table 5-2 |
| Baseline years | 2027-2041 |
| Supply elasticity | 0.29 (Coyle et al 2012) |
| Demand elasticity | -0.31 (Levin et al 2017) |

**Table 5-2: AEO 2021 Baseline Gasoline Projections, 2027-2041**

| Year | Price ($2022/gallon) | Quantity (billion gallons) |
|---|---|---|
| 2027 | 2.85 | 129.98 |
| 2028 | 2.85 | 128.32 |
| 2029 | 2.86 | 126.44 |
| 2030 | 2.87 | 124.42 |
| 2031 | 2.86 | 122.51 |
| 2032 | 2.88 | 120.68 |
| 2033 | 2.89 | 119.20 |
| 2034 | 2.90 | 117.92 |
| 2035 | 2.90 | 116.66 |
| 2036 | 2.93 | 115.37 |
| 2037 | 2.93 | 114.29 |
| 2038 | 2.94 | 113.36 |
| 2039 | 2.95 | 112.52 |
| 2040 | 2.96 | 111.91 |
| 2041 | 2.96 | 111.41 |

Source: Energy Information Administration. Annual Energy Outlook 2023. Table 12. March 16, 2023.

#### *5.2.1.3 Model Parameters*

Economic theory suggests consumers will bear a higher share of economic welfare losses if the supply of gasoline is more responsive to changes than is the demand for gasoline. Numerous peer-reviewed studies generally agree that over short periods of time demand for gasoline is price inelastic. A recent study by Levin et al. (2017) estimates short-run gasoline demand elasticity to be between -0.27 and -0.35. EPA chose the midpoint of this range, -0.31, as the primary choice for this market analysis. A meta-analysis by Labandeira, Labeaga, and Lopez-Otero (2017) estimates a short-run gasoline elasticity of demand of -0.293 (significant at the 1 percent level), which is within the range from Levin et al. (and near the mid-point of that range chosen for this analysis). This is in line with other recent estimates by Coglianese et al. (2016) of -0.37 and Bento at al. (2009) of -0.35. A demand elasticity of -0.31 suggests that a 10 percent increase in the price of gasoline will lead to an approximately 3.1 percent reduction in the quantity of gasoline demanded.

There is relatively less empirical work on the elasticity of gasoline supply. For this analysis, EPA chose the short-run estimate of 0.29 from Coyle, DeBacker, and Prisinzano (2012). This is close to the value of 0.24 used in the Economic Impact Analysis for the 2008 Gasoline Distribution Area Source NESHAP, which came from an estimate of supply elasticity for refined petroleum products (Considine, 2002). It is also consistent with applied work on the incidence of gasoline taxes (Chouinard & Perloff, 2004), which suggests that the national demand elasticity for gasoline and national supply elasticity for gasoline should be roughly equal.

### 5.2.2 *Economic Impact Results*

#### *5.2.2.1 Market-Level Results*

Market-level impacts in the gasoline market caused by the final regulations are projected to be small, with the bulk of the impacts caused by the final amendments to GACT 6B. All rules cumulatively are projected to increase the price of gasoline ($2021/gallon) by less than two hundredths of a cent/gallon in each year from 2027-2041 (less than .006 percent), with about 70 percent of the increase coming from changes to GACT 6B. Further, the quantity of gasoline consumed is projected to fall by less than .002 percent in each year from 2027-2041 when the impacts of all rules are included. The maximum fall in quantity is 1.6 million gallons in 2040, against a baseline projection of 112 billion gallons[57]. Given that a barrel of crude oil produces about 20 gallons of gasoline[58], this projection implies a reduction in crude oil demand of up to 80,000 barrels in 2040. EIA projects crude oil consumption of approximately 6.3 billion barrel-of-oil equivalent (BOE) in 2040[59], so 80,000 barrels represents less than .002 percent of total demand for crude oil.

When considering the impacts of the less and more stringent alternative options, the results are qualitatively similar, but slightly smaller in the former case and slightly greater in the latter case. For tables of market impacts by year for each package of regulatory alternatives, see Chapter 8 (Appendix A).

#### *5.2.2.2 Welfare Change Estimates*

Table 5-3, Table 5-4, and Table 5-5 below present the projected welfare impacts of each rule in present value (PV) and equivalent annual value (EAV), using both a 3 percent and 7

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[57] As production adjusts to the new equilibrium, there could be changes to the emissions reductions expected under the proposed amendments. Any such effects are likely to be small.

[58] Energy Information Administration. <https://www.eia.gov/tools/faqs/faq.php?id=327&t=9#:~:text=Petroleum%20refineries%20in%20the%20United,gallon%20barrel%20of%20crude%20oil>. Accessed 1/24/2022.

[59] Energy Information Administration. Annual Energy Outlook 2023. Table 1: Total Energy Supply, Disposition, and Price Summary. Reference Case.

percent social discount rate, for the final options and the less/more stringent package of alternatives. The bulk of the welfare impacts are caused by the final amendments to GACT 6B, which is expected given the large proportion of the compliance cost for this overall action that is attributable to this rule, and for each rule the projected costs are substantially offset by cost savings from product recovery.

**Table 5-3: Welfare Impacts of Final Options, 2027-2041 (Discounted to 2024, million 2021$)**

| Rule | | 3% | | 7% | |
|---|---|---|---|---|---|
| | | PV | EAV | PV | EAV |
| MACT R | Change In Consumer Surplus[60] | -$18 | -$1.5 | -$13 | -$1.4 |
| | Change In Producer Surplus[61] | -$19 | -$1.6 | -$14 | -$1.5 |
| | Change In Welfare with Credits[62] | -$22 | -$1.8 | -$15 | -$1.7 |
| | Change in Welfare Without Credits[63] | -$38 | -$3.2 | -$27 | -$2.9 |
| GACT 6B | Change In Consumer Surplus | -$110 | -$9.3 | -$79 | -$8.7 |
| | Change In Producer Surplus | -$120 | -$10 | -$84 | -$9.2 |
| | Change In Welfare with Credits | $65 | $5.4 | $46 | $5.0 |
| | Change in Welfare Without Credits | -$230 | -$19 | -$160 | -$18 |
| NSPS XXa | Change In Consumer Surplus | -$25 | -$2.1 | -$17 | -$1.8 |
| | Change In Producer Surplus | -$27 | -$2.2 | -$18 | -$2.0 |
| | Change In Welfare with Credits | -$1.7 | -$0.1 | -$1.1 | -$0.1 |
| | Change in Welfare Without Credits | -$52 | -$4.4 | -$34 | -$3.8 |
| All | Change In Consumer Surplus | -$150 | -$13 | -$110 | -$12 |
| | Change In Producer Surplus | -$170 | -$14 | -$120 | -$13 |
| | Change In Welfare with Credits | $41 | $3.5 | $29 | $3.2 |
| | Change in Welfare Without Credits | -$320 | -$27 | -$220 | -$25 |

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[60] Changes in consumer surplus are estimated from changes in prices and quantities using the following linear approximation formula: $\Delta \mathrm{CS} = -(\Delta \mathrm{P} * \mathrm{Q_{new}}) + .5 * \Delta P * \Delta Q$.

[61] Changes in producer surplus are estimated from changes in prices and quantities using the following linear approximation formula: $\Delta \mathrm{PS} = (\Delta \mathrm{P} - \mathrm{c_k}) * Q_{new} - .5 * \Delta P * \Delta Q$.

[62] Changes in welfare with product recovery credits included is calculated by adding total product recovery credits to ΔCS + ΔPS.

[63] Changes in welfare without product recovery credits included is calculated as ΔCS + ΔPS.

**Table 5-4: Welfare Impacts of Less Stringent Alternative Options, 2027-2041 (Discounted to 2024, million 2021$)**

| Rule | | 3% | | 7% | |
|---|---|---|---|---|---|
| | | PV | EAV | PV | EAV |
| MACT R | Change In Consumer Surplus | -$13 | -$1.1 | -$9.4 | -$1.0 |
| | Change In Producer Surplus | -$13 | -$1.6 | -$10 | -$1.1 |
| | Change In Welfare with Credits | -$14 | -$1.8 | -$17 | -$1.9 |
| | Change in Welfare Without Credits | -$24 | -$3.2 | -$19 | -$2.1 |
| GACT 6B | Change In Consumer Surplus | -$39 | -$3.2 | -$27 | -$3.0 |
| | Change In Producer Surplus | -$41 | -$3.5 | -$29 | -$3.2 |
| | Change In Welfare with Credits | -$0.2 | $0.0 | -$0.2 | $0.0 |
| | Change in Welfare Without Credits | -$80 | -$6.7 | -$57 | -$6.2 |
| NSPS XXa | Change In Consumer Surplus | -$3.1 | -$0.3 | -$2.1 | -$0.2 |
| | Change In Producer Surplus | -$3.3 | -$0.3 | -$2.2 | -$0.2 |
| | Change In Welfare with Credits | -$2.3 | -$0.2 | -$1.5 | -$0.2 |
| | Change in Welfare Without Credits | -$6.5 | -$0.5 | -$4.3 | -$0.5 |
| All | Change In Consumer Surplus | -$55 | -$4.6 | -$39 | -$4.3 |
| | Change In Producer Surplus | -$59 | -$14 | -$42 | -$13 |
| | Change In Welfare with Credits | -$27 | $3.5 | -$19 | $3.2 |
| | Change in Welfare Without Credits | -$110 | -$27 | -$80 | -$25 |

**Table 5-5: Welfare Impacts of More Stringent Alternative Options, 2027-2041 (Discounted to 2024, million 2021$)**

| Rule | | 3% | | 7% | |
|---|---|---|---|---|---|
| | | PV | EAV | PV | EAV |
| MACT R | Change In Consumer Surplus | -$57 | -$4.8 | -$40 | -$4.4 |
| | Change In Producer Surplus | -$61 | -$5.1 | -$43 | -$4.8 |
| | Change In Welfare with Credits | -$98 | -$8.2 | -$70 | -$7.6 |
| | Change in Welfare Without Credits | -$118 | -$10 | -$84 | -$9.2 |
| GACT 6B | Change In Consumer Surplus | -$363 | -$30 | -$257 | -$28 |
| | Change In Producer Surplus | -$388 | -$33 | -$274 | -$30 |
| | Change In Welfare with Credits | -$395 | -$33 | -$279 | -$31 |
| | Change in Welfare Without Credits | -$751 | -$63 | -$531 | -$58 |
| NSPS XXa | Change In Consumer Surplus | -$25 | -$2.1 | -$17 | -$1.9 |
| | Change In Producer Surplus | -$27 | -$2.3 | -$18 | -$2.0 |
| | Change In Welfare with Credits | -$2.2 | -$0.2 | -$1.4 | -$0.2 |
| | Change in Welfare Without Credits | -$53 | -$4.4 | -$35 | -$3.8 |
| All | Change In Consumer Surplus | -$446 | -$37 | -$314 | -$34 |
| | Change In Producer Surplus | -$477 | -$40 | -$336 | -$37 |
| | Change In Welfare with Credits | -$496 | -$42 | -$350 | -$38 |
| | Change in Welfare Without Credits | -$923 | -$77 | -$650 | -$71 |

The national compliance cost estimates are often used to approximate the social cost of the rule. However, in cases where the engineering costs of compliance are used to estimate social cost, the burden of the regulation is typically measured as falling solely on the affected producers, who experience a profit loss exactly equal to these cost estimates. Thus, the entire loss is a change in producer surplus with no change (by assumption) in consumer surplus because no changes in price and consumption are estimated. This is typically referred to as a "full-cost absorption" scenario in which all factors of production are assumed to be fixed and firms are unable to adjust their output levels when faced with additional costs.

In contrast, this market analysis builds on the engineering cost analysis and incorporates economic theory related to producer and consumer behavior to estimate changes in market conditions. Gasoline producers can make supply adjustments that will generally affect the market environment in which they operate. As producers change levels of gasoline supply in response to a regulation, consumers are typically faced with changes in prices that cause them to alter the quantity they are willing to purchase. These changes in price and output from the market model are used to estimate the total surplus losses/gains for two types of stakeholders: gasoline consumers and producers.

#### *5.2.2.3 Limitations*

Ultimately, the regulatory program will increase the costs of supplying gasoline to consumers, and the model is designed to evaluate behavioral responses to this change in costs within a market equilibrium setting. However, the results should be viewed with the following three limitations in mind. First, the national competitive market assumption is clearly very strong because the gasoline markets in this analysis are regional. Regional price and quantity impacts could be different from the average impacts reported below if local market structures, production costs, or demand conditions are substantially different from those used in this analysis. Second, the model uses a market supply function and analyzes supply behavior at or near a single market baseline equilibrium using a supply elasticity parameter. Therefore, it does not address facility-level impacts such as closures or changes in employment. Although developing a facility-level model could potentially provide these outputs, this type of model requires substantial amounts of detailed data for individual facilities and a level of effort beyond the scope of this analysis. Finally, we do not evaluate supply-side welfare losses by segments of the gasoline supply chain.

EPA relied on the cost-to-sales ratio analysis to make inferences about the relative impacts across producers within this chain (see Section 5.3 below).

### 5.3 Small Business Impacts Analysis

The Regulatory Flexibility Act (RFA) generally requires an agency to prepare a regulatory flexibility analysis of any rule subject to notice and comment rulemaking requirements under the Administrative Procedure Act or any other statute unless the agency certifies that the rule will not have a significant economic impact on a substantial number of small entities. Small entities include small businesses, small organizations, and small governmental jurisdictions.

For purposes of assessing the impacts of this action on small entities, a small entity is defined as: (1) a small business as defined by the Small Business Administration's (SBA) regulations at 13 CFR 121.201; (2) a small governmental jurisdiction that is a government of a city, county, town, school district or special district with a population of less than 50,000; and (3) a small organization that is any not-for-profit enterprise that is independently owned and operated and is not dominant in its field. Businesses in the Gasoline Distribution source category predominately have NAICS codes 424710 (Petroleum Bulk Stations and Terminals) and 486910 (Pipeline Transportation of Refined Petroleum Products). For the SBA small business size standard definition for each NAICS classification, see below in Table 5-6.

**Table 5-6: SBA Size Standards by NAICS Code**

| NAICS Codes | NAICS Industry Description | Size Standards (in no. of employees) |
|---|---|---|
| 424710 | Petroleum Bulk Stations and Terminals | 225 |
| 486910 | Pipeline Transportation of Refined Petroleum Products | 1,500 |

Sources: U.S. Small Business Administration, Table of Standards, Effective March 17, 2023. https://www.sba.gov/document/support--table-size-standards. Accessed March 28, 2023.

This analysis contains two sections: an analysis of potential impacts on small businesses using a facility list constructed by EPA (Facility List, discussed in Section 2.2.3), and a supplementary analysis using data collected by the US Census Bureau. Using the Facility List, EPA conducted a cost-to-sales analysis to estimate the potential impacts of the final action. The EPA prefers a "sales test" as the impact methodology in small entity analyses for rulemakings as opposed to a "profits test", in which annualized compliance costs are calculated as a share of profits[64]. This is consistent with guidance published by the U.S. Small Business Administration (SBA) Office of Advocacy, which suggests that cost as a percentage of total revenues is a metric for evaluating cost impacts on small entities relative to large entities.[65] This is because revenues or sales data are commonly available for entities impacted by EPA regulations and profits data are often private or misrepresent true profits earned by firms after undertaking accounting and tax considerations. Due to data limitations, the analysis in this section does not take into account that the smallest bulk plants will be exempt from the vapor balancing requirement due to not reaching a minimum throughput threshold of 4,000 gallons per day. This exemption should cover most or all bulk plants which could otherwise experience significant impacts from the final amendments.

While a "sales test" can provide some insight as to the economic impact of an action such as this one, it assumes that the impacts of a rule are solely incident on a directly affected firm (therefore, no impact to consumers of the affected product), or solely incident on consumers of output directly affected by this action (therefore, no impact to companies that are producers of the affected product). Thus, an analysis such as this one is best viewed as providing insight on the polar examples of economic impacts: maximum impact to either directly affected companies or their consumers. A "sales test" analysis does not consider shifts in supply and demand curves to reflect intermediate economic outcomes. For a partial equilibrium analysis of the economic impacts of this action that attempts to parse impacts on consumers relative to producers, see Section 5.2.

### 5.3.1 *Small Business National Overview*

EPA constructed a facility list for the Gasoline Distribution source category. For information on how this list was constructed, see Section 2.2.3. For the initial list of 1,838 facilities, EPA identified the ultimate parent company along with revenue and employment information for 1,705 of these facilities using D&B Hoover's database. This included 118 major source facilities owned by 40 ultimate parent companies, 1,587 area source facilities owned by

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[64] More information on sales and profit tests as used in analyses done by U.S. EPA can be found in the Final Guidance for EPA Rulewriters: Regulatory Flexibility Act as Amended by the Small Business Regulatory Enforcement Fairness Act, November 2006, pp. 32-33.

[65] U.S. SBA, Office of Advocacy. 2010. A Guide for Government Agencies, How to Comply with the Regulatory Flexibility Act, Implementing the President's Small Business Agenda and Executive Order 13272.

262 ultimate parent companies, and 11 facilities known to be subject to NSPS XX owned by 8 ultimate parent companies. In total, EPA identified 268 ultimate parent companies as owners of the 1,705 facilities, of which 117 were identified as small entities (counts of parent companies do not sum over rules due to some companies owning facilities subject to multiple rules). Summary statistics for these ultimate parent companies are in Table 5-7 below.

**Table 5-7: Summary Statistics of Potentially Affected Entities**

| Rule | Size | No. of Ultimate Parent Companies | Number of Facilities | Mean Revenue (million 2021$) | Median Revenue (million 2021$) |
|---|---|---|---|---|---|
| MACT R | Small | 2 | 2 | $12 | $12 |
|  | Not Small | 38 | 116 | $43,000 | $7,700 |
| GACT 6B | Small | 116 | 181 | $100 | $26 |
|  | Not Small | 146 | 1,406 | $24,000 | $2,300 |
| NSPS XX | Small | 0 | 0 | N/A | N/A |
|  | Not Small | 8 | 11 | $72,000 | $19,000 |
| All | Small | 117 | 183 | $100 | $25 |
|  | Not Small | 151 | 1,522 | $24,000 | $2,300 |

Source: EPA Gasoline Distribution Facility List and D&B Hoover’s Database.

Only two small ultimate parent companies own a facility subject to MACT R or NSPS XX. Based on this, it is unlikely that the final amendments to MACT R or the final NSPS XXa could have a significant impact on a substantial number of small entities. However, while a large majority of area-source facilities (89 percent) are owned by ultimate parent companies not classified as small by the SBA, a substantial number of the ultimate parent companies that own area source gasoline distribution facilities are small entities (116 or 44 percent).

### 5.3.2 *Small Entity Economic Impacts*

#### *5.3.2.1 Main Screening Analysis*

Using the facility list discussed in the above section, EPA conducted cost-to-sales analysis for the final action to screen small entities for potentially significant impacts. While EPA could identify (at least in certain cases) when a facility was a pipeline breakout station or pumping station, we could not determine for bulk distribution facilities which facilities were bulk plants and which were bulk terminals. Because of this, EPA constructed “worst-case” total annualized costs for each rule and facility. This consisted of constructing a total annualized cost for each model plant and selecting the maximum for two categories of facility: “Plant or

Terminal," and "Breakout or Pumping Station." For a discussion of the model plants and the engineering cost analysis performed for this action, see Chapter 3. The worst-case costs for each rule and facility type are in Table 5-8 below.

**Table 5-8: Worst-Case Costs by Model Plant**

| Rule | Facility Type | Total Annualized Cost without Product Recovery ($2021) | Total Annualized Cost with Product Recovery ($2021) |
|---|---|---|---|
| GACT 6B | Bulk Plant or Terminal | $22,000 | $7,500 |
| | Pipeline Breakout or Pumping Station | $2,200 | $180 |
| MACT R | Bulk Terminal | $20,000 | $10,000 |
| | Pipeline Breakout Station | $5,100 | -$3,700 |
| NSPS XXa | Bulk Terminal | $130,000 | $43,000 |

The analysis proceeds as follows:

1. Assign worst-case total annualized cost to each facility based on rule and facility type.
2. Calculate total worst-case costs for each ultimate parent company by summing over a rules and facilities.
3. Calculate a cost-to-sales ratio (CSR) for each ultimate parent company.

The results of this analysis for the final options are presented below. Table 5-9 shows the distribution of costs for ultimate parent companies by rule. Table 5-10 and Table 5-11 below show the distribution of CSRs by rule and the percentage of CSRs clearing 1 percent and 3 percent for each rule.

**Table 5-9: Distribution of Estimated Per-Facility Compliance Costs by Rule and Size for Final Options (2021$)**

| Rule | Size | No. of Firms | Average Cost with Product Recovery | Average Cost without Product Recovery |
|---|---|---|---|---|
| MACT R | Small | 2 | $10,000 | $20,000 |
| | Not Small | 38 | $9,400 | $19,000 |
| GACT 6B | Small | 116 | $7,500 | $22,000 |
| | Not Small | 146 | $7,500 | $22,000 |
| NSPS XXa | Small | 0 | N/A | N/A |
| | Not Small | 8 | $43,000 | $130,000 |

| | | | | |
|---|---|---|---|---|
| All | Small | 117 | $7,700 | $23,000 |
| | Not Small | 151 | $7,900 | $23,000 |

**Table 5-10: Compliance Cost-to-Sales Ratio Distributions for Small Entities, Final Options**

| Rule | | | With Product Recovery Included | | Without Product Recovery Included | |
|---|---|---|---|---|---|---|
| | | | Mean CSR | Maximum CSR | Mean CSR | Maximum CSR |
| MACT R | No. of Small Entities | 2 | 0.12% | 0.18% | 0.23% | 0.35% |
| GACT 6B | | 116 | 0.13% | 2.23% | 0.39% | 6.56% |
| NSPS XXa | | 0 | - | - | - | - |
| All | No. of Small Entities | 117 | 0.14% | 2.23% | 0.40% | 6.56% |

**Table 5-11: Compliance Cost-to-Sales Ratio Thresholds for Small Entities - Final Options**

| Rule | | With Product Recovery Included | | Without Product Recovery Included | |
|---|---|---|---|---|---|
| | | No. of Small Entities | % of Small Entities | No. of Small Entities | % of Small Entities |
| MACT R | No. of Small Entities | 2 | 100.0% | 2 | 100.0% |
| | Greater than 1% | 0 | 0.0% | 0 | 0.0% |
| | Greater than 3% | 0 | 0.0% | 0 | 0.0% |
| GACT 6B | No. of Small Entities | 116 | 100.0% | 116 | 100.0% |
| | Greater than 1% | 4 | 3.4% | 10 | 8.6% |
| | Greater than 3% | 0 | 0.0% | 3 | 2.6% |
| NSPS XXa | No. of Small Entities | 0 | - | 0 | - |
| | Greater than 1% | - | - | - | - |
| | Greater than 3% | - | - | - | - |
| All | No. of Small Entities | 117 | 100.0% | 117 | 100.0% |
| | Greater than 1% | 4 | 3.4% | 10 | 8.5% |
| | Greater than 3% | 0 | 0.0% | 3 | 2.6% |

Given the very low average CSR for small entities (both with and without product recovery) and the low proportion of small entities with a CSR above 3 percent, it is unlikely that the final changes to MACT R and GACT 6B or final NSPS XXa would have a significant impact on a substantial number of small entities. Also, given the low (and in the case of MACT R, negative) worst-case costs associated with pipeline facilities, it is clear that the final action would not have a significant impact on a substantial number of small entities owning pipeline facilities (although there are no such facilities on the list compiled by EPA). Further, these CSRs are conservative and are likely to overstate the impact of the action on small entities.

The above analysis has one main limitation: EPA's facility list does not provide complete coverage of the Gasoline Distribution source category. Given this circumstance, it is possible that the facility list is skewed towards larger entities (which may be easier to identify) in the source category, in which case the above analysis could understate the impacts of the action on small entities. This could be a particular problem in the case of bulk gasoline plants covered by GACT 6B. This is less likely to be the case since the worst-case costs used above overstate costs for bulk plants. Also, this analysis does not take into account that the smallest bulk plants will be exempt from the vapor balancing requirement due to not reaching a minimum throughput threshold of 4,000 gallons per day. This exemption should cover most or all bulk plants which could otherwise experience significant impacts from the final amendments. Assuming a throughput of 4,000 gallons per day, 200 operating days per year, and an average rack price of $2.15 (the 2021 average) would generate $1,720,000 in revenue for the smallest bulk plants required to install loading controls. This is more revenue than all small entities with a CSR greater than 3 percent, all but 4 small entities with a CSR greater than 1 percent, and would lead to a maximum worst-case CSR of 2.96 percent. Still, considering this possibility, we supplement the analysis below using Census data.

#### *5.3.2.2 Supplementary Screening Analysis*

The facility list compiled by EPA suggests that most of the small entities affected by the final action are area sources. Further, given the facility list's gaps in coverage, it is possible the list is skewed towards larger facilities. In this section, we investigate further the possibility that the final amendments to GACT 6B could have a significant impact on small entities.

Table 5-12 below shows the number of firms and average sales for firms in various employment groups tracked by the U.S. Census Bureau. The table shows all employment groups for which a firm could be classified as a small entity under SBA size standards. Note that this is a conservatively high count of small entities in each group, since a firm may be owned by a larger ultimate parent company with employment above the SBA threshold. There are 2,197 potential small entities with NAICS classification 424710 based on this data.

This information is augmented by calculations of the cost necessary to hit a 1 percent or 3 percent CSR for a firm in each employment group with average sales, and the worst-case CSR for a firm in the group with average sales under the final changes to GACT 6B. In the smallest employment group (<5 employees), the worst-case cost without product recovery included is less than half of that required to hit the 1 percent CSR threshold under the final changes, and less than one-sixth of that required to cross the 3 percent CSR threshold. The average worst-case CSR without product recovery in the smallest employment group is 0.41 percent and is one-fourth of that or less in each larger employment group. Further, recall that the cost estimates used to construct the worst-case CSRs are likely to overstate the costs of the final requirements for small entities. This evidence also suggests that the final changes to GACT 6B will not have a substantial impact on a significant number of small entities.

In addition, we note that this action does not contain an unfunded mandate of $100 million or more as described in the Unfunded Mandates Reform Act, 2 U.S.C. 1531–1538, and does not significantly or uniquely affect small governments. The action imposes no enforceable duty on any state, local or Tribal governments or the private sector.

## Table 5-12: NAICS 424710 - Small Entity Impacts

| Size | Firms | Average Sales (2021$) | 1% CSR Threshold | 3% CSR Threshold | GACT 6B Worst-Case CSR with Product Recovery | GACT 6B Worst-Case CSR without Product Recovery |
|---|---|---|---|---|---|---|
| <5 employees | 508 | $5,400,000 | $54,000 | $160,000 | 0.14% | 0.41% |
| 5-9 employees | 415 | $23,000,000 | $230,000 | $690,000 | 0.03% | 0.10% |
| 10-14 employees | 267 | $31,000,000 | $310,000 | $920,000 | 0.02% | 0.07% |
| 15-19 employees | 144 | $37,000,000 | $370,000 | $1,100,000 | 0.02% | 0.06% |
| 20-24 employees | 121 | $52,000,000 | $520,000 | $1,600,000 | 0.01% | 0.04% |
| 25-29 employees | 83 | $37,000,000 | $370,000 | $1,100,000 | 0.02% | 0.06% |
| 30-34 employees | 65 | $59,000,000 | $590,000 | $1,800,000 | 0.01% | 0.04% |
| 35-39 employees | 60 | $74,000,000 | $740,000 | $2,200,000 | 0.01% | 0.03% |
| 40-49 employees | 92 | $56,000,000 | $560,000 | $1,700,000 | 0.01% | 0.04% |
| 50-74 employees | 115 | $250,000,000 | $2,500,000 | $7,500,000 | 0.00% | 0.01% |
| 75-99 employees | 76 | $380,000,000 | $3,800,000 | $11,000,000 | 0.00% | 0.01% |
| 100-149 employees | 83 | $110,000,000 | $1,100,000 | $3,400,000 | 0.01% | 0.02% |
| 150-199 employees | 57 | $260,000,000 | $2,600,000 | $7,700,000 | 0.00% | 0.01% |
| 200-299 employees | 69 | $140,000,000 | $1,400,000 | $4,200,000 | 0.01% | 0.02% |
| 300-399 employees | 27 | $440,000,000 | $4,400,000 | $13,000,000 | 0.00% | 0.01% |
| 400-499 employees | 15 | $590,000,000 | $5,900,000 | $18,000,000 | 0.00% | 0.00% |

Source: U.S. Census Bureau. *County Business Patterns 2017* and *Economic Census 2017*.

## 5.4 Employment Impact Analysis

This section presents a qualitative overview of the various ways that environmental regulation can affect employment. Employment impacts of environmental regulations are generally composed of a mix of potential declines and gains in different areas of the economy over time. Regulatory employment impacts can vary across occupations, regions, and industries; by labor and product demand and supply elasticities; and in response to other labor market conditions. Isolating such impacts is a challenge, as they are difficult to disentangle from employment impacts caused by a wide variety of ongoing, concurrent economic changes. The EPA continues to explore the relevant theoretical and empirical literature and to seek public comments in order to ensure that the way the EPA characterizes the employment effects of its regulations is reasonable and informative.

Environmental regulation "typically affects the distribution of employment among industries rather than the general employment level" (Arrow, et al., 1996). Even if impacts are small after long-run market adjustments to full employment, many regulatory actions have transitional effects in the short run (Office of Management and Budget, 2015). These movements of workers in and out of jobs in response to environmental regulation are potentially important and of interest to policymakers. Transitional job losses have consequences for workers that operate in declining industries or occupations, have limited capacity to migrate, or reside in communities or regions with high unemployment rates.

As indicated by the market analysis presented in Section 5.2, and the potential impacts on firms owning Gasoline Distribution facilities in Section 5.3, the final requirements are likely to cause only small shifts in gasoline consumption and prices. As a result, demand for labor employed in gasoline distribution activities and associated industries, which we estimate is approximately 66,000 employees based on 2017 Economic Census data as mentioned in Chapter 2, is unlikely to see large changes but might experience adjustments as there may be increases in compliance-related labor requirements such as labor associated with the manufacture, installation, and operation of pollution control equipment such as new or upgraded carbon adsorbers and thermal combustors (e.g. oxidizers), and monitors. In addition, there may be changes in employment due to effects on output from directly regulated sectors and sectors that consume gasoline. If gasoline price increases sufficiently as a result of this action, then revenues of firms directly regulated and those in gasoline-consuming sectors may fall and their employment may potentially decline (though such changes should likely be small in light of the estimated change in output price mentioned above). For this final action, however, we do not have the data and analysis available to quantify potential labor impacts although as explained, we expect those impacts to be relatively small.[66]

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[66] The employment analysis in this RIA is part of EPA's ongoing effort to "conduct continuing evaluations of potential loss or shifts of employment which may result from the administration or enforcement of [the Act]" pursuant to CAA section 321(a).

# 6 COMPARISON OF BENEFITS AND COSTS

In this chapter, we present a comparison of the benefits and costs of this final action. As explained in the previous chapters, all costs and benefits outlined in this RIA are estimated as the change from the baseline, which reflects the requirements already promulgated. As stated earlier in this RIA, there is no monetized estimate of the benefits for the HAP emission reductions expected to occur as a result of this final action. We do present monetized estimates for other impacts of this action, such as benefits from reduced exposure to ozone caused by VOC emissions reductions and disbenefits from increases in $CO_2$ emissions.

## 6.1 Results

As part of fulfilling analytical guidance with respect to E.O. 12866, EPA presents estimates of the present value (PV) of the benefits and costs over the period 2027 to 2041. To calculate the present value of the social net benefits of the final action, annual benefits and costs are in 2021 dollars and are discounted to 2024 at 3 percent and 7 percent discount rates as directed by the current version of OMB's Circular A-4. The EPA also presents the equivalent annualized value (EAV), which represents a flow of constant annual values that would yield a sum equivalent to the PV. The EAV represents the value of a typical cost or benefit for each year of the analysis, consistent with the estimate of the PV, in contrast to year-specific estimates.

Tables 6-1 through 6-4 presents a summary of the monetized benefits, compliance costs, and net benefits (including climate disbenefits) of each rule, and cumulatively, and the more and less stringent alternatives for in terms of present value (PV) and equivalent annualized value (EAV). Benefits related to both short- and long-term exposure to ozone are estimated. Tables presenting benefits list both figures, with short-term benefits listed first. These tables do not include non-monetized benefits/disbenefits of each rule. These benefits/disbenefits include health and climate disbenefits of secondary emissions increases in $SO_2$, $NO_2$, and CO, environmental and ecosystem impacts (which can include reduced growth and/or biomass production in sensitive trees, reduced yield and quality of crops, visible foliar injury, changed to species composition, and other changes in ecosystems and associated ecosystem services) associated with HAP and VOC emissions reductions, ozone climate impacts, and VOC health benefits occurring outside of the ozone season. While these impacts are not monetized, EPA expects they have value. For estimates of HAP emission reductions for each regulatory option, see Section 3.4. For a description of the specific HAP emitted by this source category and potential health impacts, see Section 4.2.

## Table 6-1: Summary of Monetized Benefits, Compliance Costs, and Net Benefits PV/EAV for GACT 6B, 2027-2041 (million 2021$, discounted to 2024)

| | Final | | Less Stringent Alternative | | More Stringent Alternative | |
|---|---|---|---|---|---|---|
| 3% | PV | EAV | PV | EAV | PV | EAV |
| Health Benefits | $200<br>and<br>$1,600 | $17<br>and<br>$140 | $58<br>and<br>$460 | $4.8<br>and<br>$39 | $250<br>and<br>$2,000 | $21<br>and<br>$170 |
| Climate Disbenefits(3%) | $30 | $2.5 | $30 | $2.5 | $30 | $2.5 |
| Net Compliance Costs | -$70 | -$6.0 | $0.0 | $0.0 | $390 | $33 |
| *Compliance Costs* | *$230* | *$19* | *$80* | *$6.7* | *$750* | *$63* |
| *Value of Product Recovery* | *$300* | *$25* | *$80* | *$6.7* | *$360* | *$30* |
| Net Benefits | $240<br>and<br>$1,600 | $21<br>and<br>$140 | $28<br>and<br>$430 | $2.3<br>and<br>$37 | -$170<br>and<br>$1,600 | -$15<br>and<br>$130 |
| 7% | | | | | | |
| Health Benefits | $120<br>and<br>$980 | $13<br>and<br>$110 | $34<br>and<br>$280 | $3.7<br>and<br>$30 | $150<br>and<br>$1,200 | $16<br>and<br>$130 |
| Climate Disbenefits (3%) | $30 | $2.5 | $30 | $2.5 | $30 | $2.5 |
| Net Compliance Costs | -$50 | -$5.0 | $0.0 | $0.0 | $280 | $30 |
| *Compliance Costs* | *$160* | *$18* | *$57* | *$6.2* | *$530* | *$58* |
| *Value of Product Recovery* | *$210* | *$23* | *$57* | *$6.2* | *$250* | *$28* |
| Net Benefits | $140<br>and<br>$1,000 | $16<br>and<br>$110 | $4.0<br>and<br>$250 | $1.2<br>and<br>$28 | -$160<br>and<br>$890 | -$17<br>and<br>$98 |

Note: Monetized benefits include ozone related health benefits associated with reductions in VOC emissions. The health benefits are associated with several point estimates and are presented at real discount rates of 3 and 7 percent. The two benefits estimates are separated by the word "and" to signify that they are two separate estimates. The estimates do not represent lower- and upper-bound estimates. Benefits from HAP reductions and VOC reductions outside of the ozone season remain unmonetized and are thus not reflected in the table. The unmonetized effects also include disbenefits resulting from a secondary increase in $NO_2$, $SO_2$, and CO emissions. Benefits (incorporating disbenefits) include those related to public health and climate. The health benefits are associated with several point estimates and are presented at real discount rates of 3 and 7 percent. Climate disbenefits are based on changes (increases) in $CO_2$ emissions and are calculated using four different estimates of the social cost of carbon (SC-$CO_2$) (model average at 2.5 percent, 3 percent, and 5 percent discount rates; 95th percentile at 3 percent discount rate) presented in the Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under Executive Order 13990 (IWG 2021). For the presentational purposes of this table, we show the disbenefits associated with the average SC-$CO_2$ at a 3 percent discount rate. Please see Section 4.6 for more discussion of the climate disbenefits. Net compliance costs are the compliance costs minus the value of product recovery from compliance with the rule. Hence, net compliance costs are negative if the value of product recovery exceeds the compliance costs. Rows may not appear to add correctly due to rounding.

## Table 6-2: Summary of Monetized Benefits, Compliance Costs, and Net Benefits PV/EAV for MACT R, 2027-2041 (million 2021$, discounted to 2024)

| | Final | | Less Stringent Alternative | | More Stringent Alternative | |
|---|---|---|---|---|---|---|
| 3% | PV | EAV | PV | EAV | PV | EAV |
| Health Benefits | $11<br>and<br>$87 | $0.89<br>and<br>$7.3 | $2.3<br>and<br>$19 | $0.19<br>and<br>$1.6 | $13<br>and<br>$110 | $1.1<br>and<br>$9.0 |
| Climate Disbenefits(3%) | $0 | $0 | $0 | $0 | $0 | $0 |
| Net Compliance Costs | $22 | $1.9 | $25 | $2.0 | $100 | $8.2 |
| *Compliance Costs* | *$38* | *$3.2* | *$28* | *$2.3* | *$120* | *$10* |
| *Value of Product Recovery* | *$16* | *$1.3* | *$3.4* | *$0.3* | *$20* | *$1.7* |
| Net Benefits | -$11<br>and<br>$65 | -$1.0<br>and<br>$5.4 | -$23<br>and<br>-$6.0 | -$1.8<br>and<br>-$0.40 | -$87<br>and<br>$100 | -$7.1<br>and<br>-$0.8 |
| 7% | | | | | | |
| Health Benefits | $6.3<br>and<br>$52 | $0.70<br>and<br>$5.8 | $1.4<br>and<br>$11 | $0.15<br>and<br>$1.2 | $8.0<br>and<br>$65 | $0.87<br>and<br>$7.2 |
| Climate Disbenefits (3%) | $0 | $0 | $0 | $0 | $0 | $0 |
| Net Compliance Costs | $16 | $1.6 | $17 | $1.8 | $70 | $7.6 |
| *Compliance Costs* | *$27* | *$2.9* | *$19* | *$2.1* | *$84* | *$9.2* |
| *Value of Product Recovery* | *$11* | *$1.3* | *$2.4* | *$0.3* | *$14* | *$1.6* |
| Net Benefits | -$9.7<br>and<br>$36 | -$0.91<br>and<br>$4.2 | -$16<br>and<br>$6.0 | -$1.7<br>and<br>$0.60 | -$62<br>and<br>$5.0 | -$6.7<br>and<br>-$0.4 |

Note: Monetized benefits include ozone related health benefits associated with reductions in VOC emissions. The health benefits are associated with several point estimates and are presented at real discount rates of 3 and 7 percent s. The two benefits estimates are separated by the word “and” to signify that they are two separate estimates. The estimates do not represent lower- and upper-bound estimates. Benefits from HAP reductions and VOC reductions outside of the ozone season remain unmonetized and are thus not reflected in the table. The unmonetized effects also include disbenefits resulting from a secondary increase in $NO_2$, $SO_2$, and CO emissions. Benefits (incorporating disbenefits) include those related to public health and climate. The health benefits are associated with several point estimates and are presented at real discount rates of 3 and 7 percent. Climate disbenefits are based on changes (increases) in $CO_2$ emissions and are calculated using four different estimates of the social cost of carbon (SC-$CO_2$) (model average at 2.5 percent, 3 percent, and 5 percent discount rates; 95th percentile at 3 percent discount rate) presented in the Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under Executive Order 13990 (IWG 2021). For the presentational purposes of this table, we show the disbenefits associated with the average SC-$CO_2$ at a 3 percent discount rate. Please see Section 4.6 for more discussion of the climate disbenefits. Net compliance costs are the compliance costs minus the value of product recovery from compliance with the rule. Hence, net compliance costs are negative if the value of product recovery exceeds the compliance costs. Rows may not appear to add correctly due to rounding.

## Table 6-3: Summary of Monetized Benefits, Compliance Costs, and Net Benefits PV/EAV for NSPS XXa, 2027-2041 (million 2021$, discounted to 2024)

| | Final | | Less Stringent Alternative | | More Stringent Alternative | |
|---|---|---|---|---|---|---|
| 3% | PV | EAV | PV | EAV | PV | EAV |
| Health Benefits | $34<br>and<br>$280 | $2.8<br>and<br>$24 | $2.8<br>and<br>$23 | $0.24<br>and<br>$2.0 | $34<br>and<br>$280 | $2.8<br>and<br>$24 |
| Climate Disbenefits(3%) | $4.9 | $0.41 | $4.9 | $0.41 | $4.89 | $0.41 |
| Net Compliance Costs | $2.0 | $0.20 | $2.3 | $0.19 | $2.0 | $0.2 |
| *Compliance Costs* | *$52* | *$4.4* | *$6.5* | *$0.54* | *$53* | *$4.4* |
| *Value of Product Recovery* | *$50* | *$4.2* | *$4.2* | *$0.35* | *$51* | *$4.2* |
| Net Benefits | $27<br>and<br>$270 | $2.2<br>and<br>$23 | -$4.4<br>and<br>$16 | -$0.36<br>and<br>$1.4 | $27<br>and<br>$230 | $2.2<br>and<br>23 |
| 7% | | | | | | |
| Health Benefits | $19<br>and<br>$160 | $2.1<br>and<br>$17 | $1.6<br>and<br>$13 | $0.17<br>and<br>$1.4 | $19<br>and<br>$160 | $2.1<br>and<br>$18 |
| Climate Disbenefits (3%) | $4.9 | $0.4 | $4.9 | $0.41 | $4.9 | $0.41 |
| Net Compliance Costs | $1.0 | $0.1 | $1.5 | $0.17 | $1.0 | $0.10 |
| *Compliance Costs* | *$34* | *$3.8* | *$4.3* | *$0.47* | *$35* | *$3.8* |
| *Value of Product Recovery* | *$33* | *$3.7* | *$2.8* | *$0.30* | *$34* | *$3.7* |
| Net Benefits | $13<br>and<br>$150 | $1.6<br>and<br>$16 | -$5.0<br>and<br>$6.6 | -$0.41<br>and<br>$0.82 | $13<br>and<br>$150 | $1.6<br>and<br>$17 |

Note: Monetized benefits include ozone related health benefits associated with reductions in VOC emissions. The health benefits are associated with several point estimates and are presented at real discount rates of 3 and 7 percent. The two benefits estimates are separated by the word "and" to signify that they are two separate estimates. The estimates do not represent lower- and upper-bound estimates. Benefits from HAP reductions and VOC reductions outside of the ozone season remain unmonetized and are thus not reflected in the table. The unmonetized effects also include disbenefits resulting from a secondary increase in $NO_2$, $SO_2$, and CO emissions. Benefits (incorporating disbenefits) include those related to public health and climate. The health benefits are associated with several point estimates and are presented at real discount rates of 3 and 7 percent. Climate disbenefits are based on changes (increases) in $CO_2$ emissions and are calculated using four different estimates of the social cost of carbon (SC-$CO_2$) (model average at 2.5 percent, 3 percent, and 5 percent discount rates; 95th percentile at 3 percent discount rate) presented in the Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under Executive Order 13990 (IWG 2021). For the presentational purposes of this table, we show the disbenefits associated with the average SC-$CO_2$ at a 3 percent discount rate, Please see Section 4.6 for more discussion of the climate disbenefits. Net compliance costs are the compliance costs minus the value of product recovery from compliance with the rule. Hence, net compliance costs are negative if the value of product recovery exceeds the compliance costs. Rows may not appear to add correctly due to rounding.

## Table 6-4: Summary of Monetized Benefits, Compliance Costs, and Net Benefits PV/EAV for All Rules, 2027-2041 (million 2021$, discounted to 2024)

| | Final | | Less Stringent Alternative | | More Stringent Alternative | |
|---|---|---|---|---|---|---|
| 3% | PV | EAV | PV | EAV | PV | EAV |
| Health Benefits | $240<br>and<br>$2,000 | $20<br>and<br>$170 | $63<br>and<br>$500 | $5.3<br>and<br>$42 | $290<br>and<br>$2,400 | $25<br>and<br>$200 |
| Climate Disbenefits (3%) | $35 | $2.9 | $35 | $2.9 | $35 | $2.9 |
| Net Compliance Costs | -$46 | -$3.9 | $27 | $2.2 | $490 | $41 |
| *Compliance Costs* | *$320* | *$27* | *$120* | *$9.5* | *$920* | *$77* |
| *Value of Product Recovery* | *$370* | *$31* | *$88* | *$7.3* | *$430* | *$36* |
| Net Benefits | $250<br>and<br>$2,000 | $21<br>and<br>$170 | $1.1<br>and<br>$440 | -$0.22<br>and<br>$37 | -$240<br>and<br>$1,900 | -$19<br>and<br>$160 |
| 7% | | | | | | |
| Health Benefits | $140<br>and<br>$1,200 | $16<br>and<br>$130 | $37<br>and<br>$300 | $4.0<br>and<br>$33 | $180<br>and<br>$1,400 | $19<br>and<br>$160 |
| Climate Disbenefits (3%) | $35 | $2.9 | $35 | $2.9 | $35 | $2.9 |
| Net Compliance Costs | -$33 | -$3.3 | $18 | $2.0 | $350 | $38 |
| *Compliance Costs* | *$220* | *$25* | *$80* | *$9* | *$650* | *$71* |
| *Value of Product Recovery* | *$250* | *$28* | *$62* | *$7* | *$300* | *$33* |
| Net Benefits | $140<br>and<br>$1,200 | $16<br>and<br>$130 | -$16<br>and<br>$250 | -$0.9<br>and<br>$28 | -$210<br>and<br>$1,000 | -$22<br>and<br>$120 |

Note: Monetized benefits include ozone related health benefits associated with reductions in VOC emissions. The health benefits are associated with several point estimates and are presented at real discount rates of 3 and 7 percent. The two benefits estimates are separated by the word "and" to signify that they are two separate estimates. The estimates do not represent lower- and upper-bound estimates. Benefits from HAP reductions and VOC reductions outside of the ozone season remain unmonetized and are thus not reflected in the table. The unmonetized effects also include disbenefits resulting from a secondary increase in $NO_2$, $SO_2$, and CO emissions. Benefits (incorporating disbenefits) include those related to public health and climate. The health benefits are associated with several point estimates and are presented at real discount rates of 3 and 7 percent. Climate disbenefits are based on changes (increases) in $CO_2$ emissions and are calculated using four different estimates of the social cost of carbon (SC-$CO_2$) (model average at 2.5 percent, 3 percent, and 5 percent discount rates; 95th percentile at 3 percent discount rate) presented in the Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under Executive Order 13990 (IWG 2021). For the presentational purposes of this table, we show the disbenefits associated with the average SC-$CO_2$ at a 3 percent discount rate. Please see Section 4.6 for more discussion of the climate disbenefits. Net compliance costs are the compliance costs minus the value of product recovery from compliance with the rule. Hence, net compliance costs are negative if the value of product recovery exceeds the compliance costs. Rows may not appear to add correctly due to rounding.

Given these results, the EPA expects that implementation of the GACT 6B, based solely on an economic efficiency criterion, will provide society with a relatively substantial net gain in welfare, notwithstanding the expansive set of health and environmental benefits and other impacts we were unable to quantify such as monetization of benefits from VOC emission reductions occurring outside of the ozone season (the months of October-April). The same holds true for NSPS XXa and for all final amendments considered cumulatively. For the final amendments to MACT R, net benefits are negative when considering only short-term benefits but become positive when long-term benefits of reduced exposure to ozone are taken into account. Further quantification of directly emitted VOC and HAP would increase the estimated net benefits of the final action.

## 6.2 Uncertainties and Limitations

Throughout the RIA, we considered a number of sources of uncertainty, both quantitatively and qualitatively, regarding the benefits, and costs of the final amendments. We summarize the key elements of our discussions of uncertainty here:

**Projection methods and assumptions**: Over time, more facilities are newly established or modified in each year, and to the extent the facilities remain in operation in future years, the total number of facilities subject to the action could change. Facility closure, if it occurs, affects the number of facilities subject to GACT 6B and MACT R. We assume 100 percent compliance with these final rules and existing rules, starting from when the source becomes affected. If sources do not comply with these rules, at all or as written, the cost impacts and emission reductions may be overestimated. Additionally, new control technology may become available in the future at lower cost, and we are unable to predict exactly how industry will comply with the rules in the future.

In addition, the counts of units projected to be affected by this final action are held constant. Given our analytical timeframe of 2027-2041, it is possible that the affected unit counts may change. One factor that may impact these counts, and the impacts of these rules overall, is a potential increase in electric vehicle use that could serve as a substitute for gasoline vehicles. AEO 2023 projections indicate a continued increase in battery electric and electric-hybrid vehicle use up to 2041.[67] The expected consumption of gasoline as projected for this RIA may be senstitive to such vehicle projections.

Finally, the requirements for EFR tanks under MACT R and GACT 6B require fitting controls, which will require degassing of the storage vessel. These controls must be installed at the first degassing of the storage vessel after three years from the promulgation date of the final action, but in case more than 10 years from the promulgation date of the final action. Facilities will have 3 years to identify storage vessels that need to be upgraded and identify appropriate fitting control systems that need to be installed. Facilities are allowed up to 10 years in order to align the installation of the controls with a planned degassing event, to the extent practicable, to minimize the offsetting emissions that occur due to a degassing event solely to install the fitting controls. To the extent that that not all storage vessels have fitting controls installed in the first 10 years of the analysis period, cost and emissions impacts will be overestimated during that span.

- **Years of analysis**: The years of the cost analysis are 2027, to represent the first-year facilities are fully compliant with MACT R and GACT 6B, through 2041, to represent impacts of the action over the life of installed capital equipment, as discussed in Chapter 3. Extending the analysis beyond 2041 would introduce substantial and increasing uncertainties in projected impacts of the final regulations.
- **Compliance Costs**:  There may be an opportunity cost associated with the installation of environmental controls (for purposes of mitigating the emission of pollutants) that is not reflected in the compliance costs included in Chapter 3. If environmental investment displaces investment in productive capital, the difference between the rate of return on the marginal investment (which is discretionary in nature) displaced by the mandatory environmental investment is a measure of the opportunity cost of the environmental requirement to the regulated entity. To the extent that any opportunity costs are not included in the control costs, the compliance costs presented above for this final action may be underestimated.

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[67] U.S. Energy Information Administration.  Annual Energy Outlook 2023 Narrative.  March 2023, p. 5.  Available at https://www.eia.gov/outlooks/aeo/pdf/AEO2023_Narrative.pdf.

**BPT estimates:** All national-average BPT estimates reflect the geographic distribution of the modeled emissions, which may not exactly match the emission reductions that would occur due to the action, and they may not reflect local variability in population density, meteorology, exposure, baseline health incidence rates, or other local factors for any specific location. Recently, the EPA systematically compared the changes in benefits, and concentrations where available, from its BPT technique and other reduced-form techniques to the changes in benefits and concentrations derived from full-form photochemical model representation of a few different specific emissions scenarios. Reduced form tools are less complex than the full air quality modeling, requiring less agency resources and time. That work, in which we also explore other reduced form models is referred to as the "Reduced Form Tool Evaluation Project" (Project), began in 2017, and the initial results were available at the end of 2018. The Agency's goal was to better understand the suitability of alternative reduced-form air quality modeling techniques for estimating the health impacts of criteria pollutant emissions changes in the EPA's benefit-cost analysis. The EPA continues to work to develop refined reduced-form approaches for estimating benefits. The scenario-specific emission inputs developed for this project are currently available online. The study design and methodology are described in the final report summarizing the results of the project, available at <https://www.epa.gov/sites/production/files/2019-11/documents/rft_combined_report_10.31.19_final.pdf>.

**Non-monetized benefits and disbenefits:** Numerous categories of health and welfare benefits are not quantified and monetized in this RIA. These benefits/disbenefits include health and climate disbenefits of secondary emissions increases in $SO_2$, $NO_2$, and CO, environmental and ecosystem impacts (which can include reduced growth and/or biomass production in sensitive trees, reduced yield and quality of crops, visible foliar injury, changed to species composition, and other changes in ecosystems and associated ecosystem services) associated with HAP and VOC emissions reductions, ozone climate impacts, and VOC health benefits occuring outside of the ozone season. While these impacts are not monetized, EPA expects they have value. These unquantified benefits, including benefits from reductions in emissions of pollutants such as HAP which are to be reduced by this final action, are described in detail in Chapter 4 of this RIA and various NAAQS RIAs.

**VOC health impacts**: In this RIA, we quantify an array of adverse health impacts attributable to emissions of VOC. The Integrated Science Assessment for Particulate Matter (“ ISA”) (U.S. EPA, 2019) identifies the human health effects associated with ambient particles, which include premature death and a variety of illnesses associated with acute and chronic exposures.

**Monetized climate disbenefits**: The EPA considered the uncertainty associated with the interim global social cost of carbon (SC-$CO_2$) estimates, which were used to calculate the climate disbenefits from the increase in $CO_2$ emissions projected under the final amendments to NSPS XX and GACT 6B. Some uncertainties are captured within the analysis, while other areas of uncertainty have not yet been quantified in a way that can be modeled. A full list and discussion of uncertainties in the analysis of monetized climate disbenefits can be found in Section 4.6 of this RIA.

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# 8 APPENDIX A: DETAILED MARKET IMPACT TABLES

## 8.1 Final Options

### 8.1.1 *Price Impacts*

**Table 8-1: Projected Change in Price, Final Options (2021 cents/gallon of gasoline)**

| Year | NSPS XXa | MACT R | GACT 6B | All |
|---|---|---|---|---|
| 2027 | 0.0008 | 0.0012 | 0.0076 | 0.0096 |
| 2028 | 0.0009 | 0.0013 | 0.0077 | 0.0099 |
| 2029 | 0.0011 | 0.0013 | 0.0078 | 0.0100 |
| 2030 | 0.0013 | 0.0013 | 0.0080 | 0.0110 |
| 2031 | 0.0014 | 0.0013 | 0.0081 | 0.0110 |
| 2032 | 0.0016 | 0.0013 | 0.0082 | 0.0110 |
| 2033 | 0.0018 | 0.0014 | 0.0083 | 0.0110 |
| 2034 | 0.0020 | 0.0014 | 0.0084 | 0.0120 |
| 2035 | 0.0022 | 0.0014 | 0.0085 | 0.0120 |
| 2036 | 0.0024 | 0.0014 | 0.0086 | 0.0120 |
| 2037 | 0.0026 | 0.0014 | 0.0087 | 0.0130 |
| 2038 | 0.0027 | 0.0014 | 0.0087 | 0.0130 |
| 2039 | 0.0029 | 0.0014 | 0.0088 | 0.0130 |
| 2040 | 0.0031 | 0.0014 | 0.0089 | 0.0130 |
| 2041 | 0.0033 | 0.0015 | 0.0089 | 0.0140 |

**Table 8-2: Projected Percentage Change in Price, Final Options**

| Year | NSPS XXa | MACT R | GACT 6B | All |
|---|---|---|---|---|
| 2027 | 0.0003% | 0.0004% | 0.0027% | 0.0034% |
| 2028 | 0.0003% | 0.0004% | 0.0027% | 0.0035% |
| 2029 | 0.0004% | 0.0004% | 0.0027% | 0.0036% |
| 2030 | 0.0004% | 0.0005% | 0.0028% | 0.0037% |
| 2031 | 0.0005% | 0.0005% | 0.0028% | 0.0038% |
| 2032 | 0.0006% | 0.0005% | 0.0029% | 0.0039% |
| 2033 | 0.0006% | 0.0005% | 0.0029% | 0.0040% |
| 2034 | 0.0007% | 0.0005% | 0.0029% | 0.0041% |
| 2035 | 0.0007% | 0.0005% | 0.0029% | 0.0042% |
| 2036 | 0.0008% | 0.0005% | 0.0029% | 0.0042% |
| 2037 | 0.0009% | 0.0005% | 0.0030% | 0.0043% |
| 2038 | 0.0009% | 0.0005% | 0.0030% | 0.0044% |
| 2039 | 0.0010% | 0.0005% | 0.0030% | 0.0045% |
| 2040 | 0.0011% | 0.0005% | 0.0030% | 0.0045% |
| 2041 | 0.0011% | 0.0005% | 0.0030% | 0.0046% |

### 8.1.2 *Quantity Impacts*

**Table 8-3: Projected Change in Quantity, Final Options (gallons of gasoline)**

| Year | NSPS XXa | MACT R | GACT 6B | All |
|---|---|---|---|---|
| 2027 | -110,000 | -180,000 | -1,100,000 | -1,400,000 |
| 2028 | -130,000 | -180,000 | -1,100,000 | -1,400,000 |
| 2029 | -150,000 | -180,000 | -1,100,000 | -1,400,000 |
| 2030 | -170,000 | -170,000 | -1,100,000 | -1,400,000 |
| 2031 | -190,000 | -180,000 | -1,100,000 | -1,400,000 |
| 2032 | -210,000 | -170,000 | -1,100,000 | -1,500,000 |
| 2033 | -230,000 | -170,000 | -1,100,000 | -1,500,000 |
| 2034 | -250,000 | -170,000 | -1,100,000 | -1,500,000 |
| 2035 | -270,000 | -170,000 | -1,100,000 | -1,500,000 |
| 2036 | -290,000 | -170,000 | -1,000,000 | -1,500,000 |
| 2037 | -310,000 | -170,000 | -1,000,000 | -1,500,000 |
| 2038 | -330,000 | -170,000 | -1,000,000 | -1,500,000 |
| 2039 | -350,000 | -170,000 | -1,000,000 | -1,600,000 |
| 2040 | -370,000 | -170,000 | -1,000,000 | -1,600,000 |
| 2041 | -390,000 | -170,000 | -1,000,000 | -1,600,000 |

**Table 8-4: Percentage Change in Quantity, Final Options**

| Year | NSPS XXa | MACT R | GACT 6B | All |
|---|---|---|---|---|
| 2027 | -0.0001% | -0.0001% | -0.0008% | -0.0010% |
| 2028 | -0.0001% | -0.0001% | -0.0008% | -0.0011% |
| 2029 | -0.0001% | -0.0001% | -0.0008% | -0.0011% |
| 2030 | -0.0001% | -0.0001% | -0.0009% | -0.0011% |
| 2031 | -0.0002% | -0.0001% | -0.0009% | -0.0012% |
| 2032 | -0.0002% | -0.0001% | -0.0009% | -0.0012% |
| 2033 | -0.0002% | -0.0001% | -0.0009% | -0.0012% |
| 2034 | -0.0002% | -0.0001% | -0.0009% | -0.0013% |
| 2035 | -0.0002% | -0.0001% | -0.0009% | -0.0013% |
| 2036 | -0.0003% | -0.0001% | -0.0009% | -0.0013% |
| 2037 | -0.0003% | -0.0001% | -0.0009% | -0.0013% |
| 2038 | -0.0003% | -0.0002% | -0.0009% | -0.0014% |
| 2039 | -0.0003% | -0.0002% | -0.0009% | -0.0014% |
| 2040 | -0.0003% | -0.0002% | -0.0009% | -0.0014% |
| 2041 | -0.0003% | -0.0002% | -0.0009% | -0.0014% |

## 8.2 Less Stringent Alternative Options

### 8.2.1 *Price Impacts*

**Table 8-5: Projected Change in Price, Less Stringent Alternative Options (2021 cents/gallon of gasoline)**

| Year | NSPS XXa | MACT R | GACT 6B | All |
|---|---|---|---|---|
| 2027 | 0.0001 | 0.0009 | 0.0027 | 0.0037 |
| 2028 | 0.0001 | 0.0009 | 0.0027 | 0.0037 |
| 2029 | 0.0001 | 0.0009 | 0.0027 | 0.0038 |
| 2030 | 0.0002 | 0.0010 | 0.0028 | 0.0039 |
| 2031 | 0.0002 | 0.0010 | 0.0028 | 0.0040 |
| 2032 | 0.0002 | 0.0010 | 0.0029 | 0.0040 |
| 2033 | 0.0002 | 0.0010 | 0.0029 | 0.0041 |
| 2034 | 0.0003 | 0.0010 | 0.0029 | 0.0042 |
| 2035 | 0.0003 | 0.0010 | 0.0030 | 0.0042 |
| 2036 | 0.0003 | 0.0010 | 0.0030 | 0.0043 |
| 2037 | 0.0003 | 0.0010 | 0.0030 | 0.0044 |
| 2038 | 0.0003 | 0.0010 | 0.0030 | 0.0044 |
| 2039 | 0.0004 | 0.0011 | 0.0031 | 0.0045 |
| 2040 | 0.0004 | 0.0011 | 0.0031 | 0.0045 |
| 2041 | 0.0004 | 0.0011 | 0.0031 | 0.0046 |

**Table 8-6: Projected Percentage Change in Price, Less Stringent Alternative Options**

| Year | NSPS XXa | MACT R | GACT 6B | All |
|---|---|---|---|---|
| 2027 | 0.0000% | 0.0003% | 0.0009% | 0.0013% |
| 2028 | 0.0000% | 0.0003% | 0.0009% | 0.0013% |
| 2029 | 0.0000% | 0.0003% | 0.0010% | 0.0013% |
| 2030 | 0.0001% | 0.0003% | 0.0010% | 0.0014% |
| 2031 | 0.0001% | 0.0003% | 0.0010% | 0.0014% |
| 2032 | 0.0001% | 0.0003% | 0.0010% | 0.0014% |
| 2033 | 0.0001% | 0.0003% | 0.0010% | 0.0014% |
| 2034 | 0.0001% | 0.0003% | 0.0010% | 0.0014% |
| 2035 | 0.0001% | 0.0004% | 0.0010% | 0.0015% |
| 2036 | 0.0001% | 0.0004% | 0.0010% | 0.0015% |
| 2037 | 0.0001% | 0.0004% | 0.0010% | 0.0015% |
| 2038 | 0.0001% | 0.0004% | 0.0010% | 0.0015% |
| 2039 | 0.0001% | 0.0004% | 0.0010% | 0.0015% |
| 2040 | 0.0001% | 0.0004% | 0.0010% | 0.0015% |
| 2041 | 0.0001% | 0.0004% | 0.0010% | 0.0015% |

### 8.2.2 *Quantity Impacts*

**Table 8-7: Projected Change in Quantity, Less Stringent Alternative Options (gallons of gasoline)**

| Year | NSPS XXa | MACT R | GACT 6B | All |
|---|---|---|---|---|
| 2027 | -13,000 | -130,000 | -370,000 | -520,000 |
| 2028 | -16,000 | -130,000 | -370,000 | -520,000 |
| 2029 | -18,000 | -130,000 | -370,000 | -520,000 |
| 2030 | -21,000 | -130,000 | -370,000 | -520,000 |
| 2031 | -24,000 | -130,000 | -370,000 | -530,000 |
| 2032 | -26,000 | -130,000 | -370,000 | -530,000 |
| 2033 | -29,000 | -130,000 | -370,000 | -530,000 |
| 2034 | -31,000 | -130,000 | -370,000 | -530,000 |
| 2035 | -34,000 | -130,000 | -370,000 | -530,000 |
| 2036 | -36,000 | -130,000 | -360,000 | -530,000 |
| 2037 | -38,000 | -130,000 | -360,000 | -530,000 |
| 2038 | -41,000 | -120,000 | -360,000 | -530,000 |
| 2039 | -43,000 | -120,000 | -360,000 | -530,000 |
| 2040 | -46,000 | -120,000 | -360,000 | -530,000 |
| 2041 | -48,000 | -120,000 | -360,000 | -530,000 |

**Table 8-8: Percentage Change in Quantity, Less Stringent Alternative Options**

| Year | NSPS XXa | MACT R | GACT 6B | All |
|---|---|---|---|---|
| 2027 | 0.0000% | -0.0001% | -0.0003% | -0.0004% |
| 2028 | 0.0000% | -0.0001% | -0.0003% | -0.0004% |
| 2029 | 0.0000% | -0.0001% | -0.0003% | -0.0004% |
| 2030 | 0.0000% | -0.0001% | -0.0003% | -0.0004% |
| 2031 | 0.0000% | -0.0001% | -0.0003% | -0.0004% |
| 2032 | 0.0000% | -0.0001% | -0.0003% | -0.0004% |
| 2033 | 0.0000% | -0.0001% | -0.0003% | -0.0004% |
| 2034 | 0.0000% | -0.0001% | -0.0003% | -0.0004% |
| 2035 | 0.0000% | -0.0001% | -0.0003% | -0.0005% |
| 2036 | 0.0000% | -0.0001% | -0.0003% | -0.0005% |
| 2037 | 0.0000% | -0.0001% | -0.0003% | -0.0005% |
| 2038 | 0.0000% | -0.0001% | -0.0003% | -0.0005% |
| 2039 | 0.0000% | -0.0001% | -0.0003% | -0.0005% |
| 2040 | 0.0000% | -0.0001% | -0.0003% | -0.0005% |
| 2041 | 0.0000% | -0.0001% | -0.0003% | -0.0005% |

## 8.3 More Stringent Alternative Options

### 8.3.1 *Price Impacts*

**Table 8-9: Projected Change in Price, More Stringent Alternative Options (2021 cents/gallon of gasoline)**

| Year | NSPS XXa | MACT R | GACT 6B | All |
|---|---|---|---|---|
| 2027 | 0.0008 | 0.0039 | 0.0250 | 0.0300 |
| 2028 | 0.0009 | 0.0040 | 0.0250 | 0.0300 |
| 2029 | 0.0011 | 0.0040 | 0.0260 | 0.0310 |
| 2030 | 0.0013 | 0.0041 | 0.0260 | 0.0310 |
| 2031 | 0.0015 | 0.0042 | 0.0260 | 0.0320 |
| 2032 | 0.0016 | 0.0042 | 0.0270 | 0.0330 |
| 2033 | 0.0018 | 0.0043 | 0.0270 | 0.0330 |
| 2034 | 0.0020 | 0.0043 | 0.0270 | 0.0340 |
| 2035 | 0.0022 | 0.0044 | 0.0280 | 0.0340 |
| 2036 | 0.0024 | 0.0044 | 0.0280 | 0.0350 |
| 2037 | 0.0026 | 0.0045 | 0.0280 | 0.0350 |
| 2038 | 0.0028 | 0.0045 | 0.0280 | 0.0360 |
| 2039 | 0.0030 | 0.0045 | 0.0290 | 0.0360 |
| 2040 | 0.0032 | 0.0045 | 0.0290 | 0.0370 |
| 2041 | 0.0034 | 0.0046 | 0.0290 | 0.0370 |

**Table 8-10: Projected Percentage Change in Price, More Stringent Alternative Options**

| Year | NSPS XXa | MACT R | GACT 6B | All |
|---|---|---|---|---|
| 2027 | 0.0003% | 0.0014% | 0.0087% | 0.0103% |
| 2028 | 0.0003% | 0.0014% | 0.0088% | 0.0105% |
| 2029 | 0.0004% | 0.0014% | 0.0089% | 0.0107% |
| 2030 | 0.0004% | 0.0014% | 0.0091% | 0.0109% |
| 2031 | 0.0005% | 0.0015% | 0.0092% | 0.0112% |
| 2032 | 0.0006% | 0.0015% | 0.0093% | 0.0113% |
| 2033 | 0.0006% | 0.0015% | 0.0094% | 0.0115% |
| 2034 | 0.0007% | 0.0015% | 0.0095% | 0.0117% |
| 2035 | 0.0008% | 0.0015% | 0.0095% | 0.0118% |
| 2036 | 0.0008% | 0.0015% | 0.0096% | 0.0119% |
| 2037 | 0.0009% | 0.0015% | 0.0096% | 0.0120% |
| 2038 | 0.0009% | 0.0015% | 0.0097% | 0.0122% |
| 2039 | 0.0010% | 0.0015% | 0.0097% | 0.0123% |
| 2040 | 0.0011% | 0.0015% | 0.0098% | 0.0124% |
| 2041 | 0.0011% | 0.0015% | 0.0098% | 0.0125% |

### 8.3.2 *Quantity Impacts*

**Table 8-11: Projected Change in Quantity, More Stringent Alternative Options (gallons of gasoline)**

| Year | NSPS XXa | MACT R | GACT 6B | All |
|---|---|---|---|---|
| 2027 | -110,000 | -550,000 | -3,500,000 | -4,200,000 |
| 2028 | -130,000 | -550,000 | -3,500,000 | -4,200,000 |
| 2029 | -150,000 | -550,000 | -3,500,000 | -4,200,000 |
| 2030 | -170,000 | -550,000 | -3,500,000 | -4,200,000 |
| 2031 | -190,000 | -550,000 | -3,500,000 | -4,200,000 |
| 2032 | -210,000 | -550,000 | -3,500,000 | -4,200,000 |
| 2033 | -230,000 | -550,000 | -3,500,000 | -4,300,000 |
| 2034 | -250,000 | -550,000 | -3,500,000 | -4,300,000 |
| 2035 | -270,000 | -540,000 | -3,500,000 | -4,300,000 |
| 2036 | -290,000 | -540,000 | -3,400,000 | -4,200,000 |
| 2037 | -310,000 | -540,000 | -3,400,000 | -4,300,000 |
| 2038 | -330,000 | -540,000 | -3,400,000 | -4,300,000 |
| 2039 | -350,000 | -530,000 | -3,400,000 | -4,300,000 |
| 2040 | -370,000 | -530,000 | -3,400,000 | -4,300,000 |
| 2041 | -390,000 | -530,000 | -3,400,000 | -4,300,000 |

**Table 8-12: Percentage Change in Quantity, More Stringent Alternative Options**

| Year | NSPS XXa | MACT R | GACT 6B | All |
|---|---|---|---|---|
| 2027 | -0.0001% | -0.0004% | -0.0027% | -0.0032% |
| 2028 | -0.0001% | -0.0004% | -0.0027% | -0.0033% |
| 2029 | -0.0001% | -0.0004% | -0.0028% | -0.0033% |
| 2030 | -0.0001% | -0.0004% | -0.0028% | -0.0034% |
| 2031 | -0.0002% | -0.0004% | -0.0029% | -0.0035% |
| 2032 | -0.0002% | -0.0005% | -0.0029% | -0.0035% |
| 2033 | -0.0002% | -0.0005% | -0.0029% | -0.0036% |
| 2034 | -0.0002% | -0.0005% | -0.0029% | -0.0036% |
| 2035 | -0.0002% | -0.0005% | -0.0030% | -0.0037% |
| 2036 | -0.0003% | -0.0005% | -0.0030% | -0.0037% |
| 2037 | -0.0003% | -0.0005% | -0.0030% | -0.0037% |
| 2038 | -0.0003% | -0.0005% | -0.0030% | -0.0038% |
| 2039 | -0.0003% | -0.0005% | -0.0030% | -0.0038% |
| 2040 | -0.0003% | -0.0005% | -0.0030% | -0.0038% |
| 2041 | -0.0004% | -0.0005% | -0.0030% | -0.0039% |

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