Economic Impact Analysis for the Final National Emissions Standards for Hazardous Air Pollutants: Plywood and Composite Wood Products Amendments

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Economic Impact Analysis for the Final National Emissions Standards for Hazardous Air Pollutants: Plywood and Composite Wood Products Amendments

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1 INTRODUCTION

This document presents the U.S. Environmental Protection Agency's (EPA) economic impact analysis (EIA) for final amendments to the National Emission Standards for Hazardous Air Pollutants (NESHAP) for facilities in the Plywood and Composite Wood Products (PCWP) source category (40 CFR part 63, subpart DDDD).

The PCWP source category comprises lumber kilns located at any facility, facilities that manufacture kiln-dried lumber, facilities that manufacture dry veneer, and facilities that manufacture plywood and/or composite wood products by bonding wood material (fibers, particles, strands, veneers, etc.) or agricultural fiber, generally with resin under heat and pressure, to form a structural panel, reconstituted wood product, or engineered wood product. Plywood and composite wood products include, but are not limited to, veneer, plywood, particleboard, oriented strandboard, hardboard, fiberboard, medium density fiberboard, glue-laminated beams, structural composite lumber, and wood I-joists.

There are currently 219 major source facilities subject to the PCWP NESHAP, including 126 facilities producing kiln-dried lumber, 78 manufacturing PCWP, and 15 producing both kiln-dried lumber and PCWP. A major source of HAP is a facility that emits or has the potential to emit any single HAP at a rate of 9.07 megagrams (10 tons) or more or any combination of HAP at a rate of 22.68 megagrams (25 tons) or more per year from all emission sources at the facility.

The affected source encompasses equipment and operations at facilities included in the PCWP source category. The affected source is the collection of dryers, refiners, blenders, formers, presses, board coolers, and other process units associated with the manufacturing of PCWP. The affected source includes, but is not limited to, green end operations, refining, drying operations (including any combustion unit exhaust stream routinely used to direct fire process unit(s)), resin preparation, blending and forming operations, pressing and board cooling operations, and miscellaneous finishing operations (such as sanding, sawing, patching, edge sealing, and other finishing operations not subject to other NESHAP). The affected source also includes onsite storage and preparation of raw materials used in the manufacture of PCWP, such as resins; onsite wastewater treatment operations specifically associated with PCWP manufacturing; miscellaneous coating operations; and lumber kilns at PCWP manufacturing facilities and at any other kind of facility.

This final rule updates and finalizes amendments to 40 CFR part 63, subpart DDDD, that were initially proposed on May 18, 2023 (88 FR 31856). The rule finalizes standards for lumber kilns and process units with previous "no control" MACT determinations that were vacated in 2007. The rule also finalizes standards for emissions of previously unregulated HAP, including resin-related HAP and combustion-related HAP. Lastly, the amendments update, clarify, and revise performance testing, monitoring, recordkeeping, and reporting requirements, as well as compliance options. Table 1-1 presents a high-level summary of the amendments to the PCWP NESHAP finalized by this rule.

Table 1-1 Summary of Final Amendments

Action	Summary
Finalize standards for lumber kilns	Establishes work practice standards to limit emissions of organic HAP, combustion-related HAP, and VOCs from lumber kilns.
Finalize standards for organic HAP emitted by process units with previous "no-control" MACT determinations	Establishes numeric standards for organic HAP for new and existing atmospheric refiners and heated zones of existing fiberboard mat dryers and press predryers; establishes work practice standards for new and existing resinated material handling process units, stand-alone digesters, fiber washers, and log vats; and defines mixed PCWP process emissions streams subject to the NESHAP.
Finalize standards for previously unregulated resin-related HAP	Establishes numeric standards for MDI emissions for reconstituted wood products presses, tube dryers that blow-line blend MDI resin, and miscellaneous coating operations.
Finalize standards for previously unregulated combustion-related HAP	Establishes numeric standards for emissions of combustion-related HAP for new and existing direct wood-fired dryers; establishes work practice standards to limit emissions of combustion-related HAP, including D/F, by requiring burner tune-ups for burners associated with direct wood-fired and direct natural gas-fired dryers and by requiring continuous monitoring of an indicator of combustion unit bypass stack usage associated with PCWP dryers and lumber kilns.
Other updates and revisions	Establishes performance testing requirements for new and existing source emission limits; establishes monitoring, recordkeeping, and reporting requirements; removes obsolete rule language including the emissions averaging compliance option for existing affected sources, dates, and startup/shutdown provisions that are no longer in effect; and updates and clarifies electronic reporting requirements.

For this final rule, the EPA has followed the directions of E.O. 12866 and Circular A-4 in publishing an impact analysis characterizing the potential costs and benefits of the final rule, soliciting public comment on the proposed rulemaking, and now providing an updated analysis in this EIA comparing the costs the final rule to a no action alternative in the baseline. Specifically, the EPA's analysis considers the human health benefits from changes in emissions from the regulated facilities and the increased compliance costs associated with new regulatory requirements. This EIA also describes the broader potential economic impacts of this rulemaking, employment effects, and various unquantified impacts.

2 INDUSTRY PROFILE

This industry profile updates and summarizes information from an earlier version that was prepared for the May 18, 2023, proposed rule, that had, in turn, adapted the profile developed for the 2020 RTR.[1], [2] This industry profile includes a brief description of PCWP products and production processes as well as an updated summary of industry and market conditions for contextualizing the engineering, emissions, and economic analyses included later in chapters 3, 4, and 5 of this EIA. For a more comprehensive overview of PCWP products and production processes, please refer to chapter 10 of the EPA's *AP-42: Compilation of Air Emissions Factors from Stationary Sources* as well as earlier versions of the industry profile.[3]

This industry profile describes industries in the PCWP source category expected to be affected by the amendments to the PCWP NESHAP. The EPA surveyed potentially impacted facilities during an earlier ICR and determined that approximately 219 existing facilities may be impacted by the final rule. Table 2-1 presents the North American Industry Classification System (NAICS) codes for the industries of facilities expected to be affected by the amendments. Note that the sum of the number of facilities in Table 2-1 is greater than the total number of facilities subject to this rulemaking (219) because some facilities produce products classified under multiple NAICS categories.

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[1] U.S. EPA. (2023). Economic Impact Analysis for the National Emission Standards for Hazardous Air Pollutants: Plywood and Composite Wood Products Amendments (EPA-452/R-23-008). Retrieved from docket: https://www.epa.gov/system/files/documents/2023-05/Proposed_PCWP_EIA.pdf.

[2] U.S. EPA. (2019a). Economic Impact and Small Business Analysis for the Proposed Plywood and Composite Wood Products (PCWP) Risk and Technology Review (RTR) NESHAP. Retrieved from docket: https://www.regulations.gov/document/EPA-HQ-OAR-2016-0243-0185.

[3] U.S. EPA. (2002a). AP-42: Compilation of Air Emissions Factors from Stationary Sources, Chapter 10: Wood Products Industry. https://www.epa.gov/air-emissions-factors-and-quantification/ap-42-fifth-edition-volume-i-chapter-10-wood-products-0.

Table 2-1 Impacted PCWP Facilities by Industry

NAICS Code	NAICS Description	Impacted Facilities
321113	Sawmills	141
321211	Hardwood Veneer and Plywood Manufacturing	1
321212	Softwood Veneer and Plywood Manufacturing	33
321215	Engineered Wood Member Manufacturing	11
321219	Reconstituted Wood Product Manufacturing	52
	Medium Density Fiberboard	17
	Hardboard	3
	Oriented Strandboard	25
	Particleboard	11
321999	All Other Miscellaneous Wood Product Manufacturing	0

2.1 PRODUCTS AND PRODUCTION PROCESSES

Sawmills (NAICS 321113) process industrial roundwood into sawnwood. The process includes sorting and debarking, sawing, sorting and grading, drying, regrading, then surfacing. Because freshly sawn lumber has high moisture content, mills use lumber kilns to dry sawn lumber for many end uses. Most mills use batch kilns, though mills in the Southeast also use continuous dry kilns.

Hardwood (NAICS 321211) and softwood (NAICS 321212) plywood manufacturers produce plywood by bonding veneers (thin wood layers or plies) with an adhesive. Hardwood plywood is used in applications such as furniture, cabinets, paneling, flooring, and doors. Softwood plywood is used in less visible applications, including wall siding, roof decking, and containers. There are nine main processes in hardwood or softwood veneer and plywood production: log storage, log debarking and bucking, heating the logs, peeling the logs into veneers, drying the veneers, gluing the veneers together, pressing the veneers in a hot press, plywood cutting, and other finishing processes such as sanding.

Engineered wood products manufacturers (NAICS 321215) create products from lumber, veneers, wood strands, and other small wood elements, binding them with structural resins to create lumber-like structural members. They design these products for the same structural applications as swanwood (*e.g.*, girders, beams, headers, joists, studs, columns). Examples of engineered wood members include laminated veneer lumber, parallel strand lumber, I-joists, and glue-laminated beams. These products let producers create large-lumber substitutes from small, lower-grade logs.

Reconstituted wood products manufacturers (NAICS 321219) make products from wood particles, fibers, or strands, which they obtain by flaking or chipping logs or by purchasing trim products from other wood processors (*e.g.*, softwood plywood manufacturers or sawmills). After drying the wood furnish, they apply resin, form the furnish into a mat, and press it under heat and pressure to cure the adhesive and bond the panel. They then cool the bonded panel and process it to the required width, length, and surface for different products. Examples of reconstituted wood products include fiberboard, such as medium density fiberboard and hardboard, oriented strandboard, and particleboard.

Thicker medium density fiberboard panels are used as core material in furniture panels, while builders typically use thinner panels for siding. Manufacturers produce medium density fiberboard by mechanically pulping wood chips into fibers (refining), drying, blending the fibers with resin and sometimes wax, forming the resinated material into a mat, and hot pressing.

Hardboard is often used for housing (*e.g.*, exterior siding, garage doors, interior door facings), furniture, store fixtures, automotive interiors, and toys. Manufacturers most often start with wood chips, soften them in a pressurized steam digester, and refine or pulp them into wood fibers; they may also use shavings or sawdust. They then mix the fibers with resin, form mats, press, and dry them. Manufacturers make hardboard by dry processing, wet processing, or wet/dry processing. In dry processing, they form a dry mat and press it; in wet processing, they wet-form and wet-press; in wet/dry processing, they wet-form and then dry-press. They use resin in wet and dry processing but not in wet/dry processing.

Oriented strandboard is a substitute for softwood plywood in applications including sheathing, single-layer flooring, and underlayment in light-frame construction. Manufacturers make oriented strandboard from wood wafers. They blend long, narrow flakes (strands) with resin and form a three- or five-layer mat. They align strands in each layer perpendicular to adjacent layers to achieve desirable flexural properties.

Particleboard differs from other reconstituted wood products primarily in the material or particles manufacturers use. In particleboard production, manufacturers commonly use wood shavings, flakes, wafers, chips, sawdust, strands, slivers, and wood wool. They form most particleboard into panels; however, they also produce molded particleboard products such as furniture parts, door skins, or molded pallets.

The PCWP NESHAP covers HAP emissions from process units used during PCWP production processes such as log vats, digesters, atmospheric refiners, resinated material handling units (*e.g.*, presses, blenders, formers), as well as dryers and other process units. Boilers for onsite steam production and coating processes lead to further emissions in the manufacturing of PCWP, but these processes are outside of the PCWP source category (*i.e.*, are subject to separate NESHAP).

Air pollution controls used to reduce HAP emissions from PCWP production processes include regenerative thermal oxidizers (RTOs), regenerative catalytic oxidizers (RCOs), incineration of exhaust in an onsite combustion unit such as a boiler (referred to as “process incineration”), and biofilters. Wet electrostatic precipitators (WESP) or other particulate matter controls may be used upstream of HAP control devices to prevent plugging of the HAP control with sticky particulates.

2.2 INDUSTRY AND MARKET CONDITIONS

This section presents updated information on industry and market conditions originally described in the EIA that was prepared for the May 18, 2023, proposed rule.[4] It begins with a summary of current industry characteristics, focusing on location of PCWP facilities, employment, capacity utilization, and industry concentration. It then describes recent market conditions.

2.2.1 Location of PCWP Facilities

Facilities that manufacture wood products are generally located in rural areas – especially the South, Pacific Northwest, and Midwest – with Maine, Pennsylvania, and California also potentially affected by the regulation. Table 2-2 shows the location of the potentially impacted existing facilities identified by the EPA.

Table 2-2 PCWP Potentially Impacted Facility Locations

State	No. Impacted Facilities	State	No. Impacted Facilities	State	No. Impacted Facilities
Alabama	23	Michigan	3	South Carolina	17
Arkansas	16	Mississippi	20	South Dakota	1
California	7	Missouri	1	Tennessee	1
Florida	9	Montana	2	Texas	10
Georgia	24	North Carolina	15	Virginia	5
Idaho	4	Oklahoma	4	Washington	11
Louisiana	16	Oregon	21	West Virginia	3
Maine	2	Pennsylvania	3	Wisconsin	1

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[4] U.S. EPA. (2023). Economic Impact Analysis for the National Emission Standards for Hazardous Air Pollutants: Plywood and Composite Wood Products Amendments (EPA-452/R-23-008). Retrieved from docket: https://www.epa.gov/system/files/documents/2023-05/Proposed_PCWP_EIA.pdf.

2.2.2 Employment at PCWP Facilities

Figure 2-1 shows national employment trends in the wood products manufacturing industry (NAICS 321) using data from the Current Employment Statistics survey published by the U.S. Bureau of Labor Statistics (BLS). From 2016 to 2020, the industry added jobs, increasing employment from around 390,000 to 410,000 before experiencing job losses. The industry recovered between 2020 and 2022, when the number of employees grew from approximately 375,000 in 2020 to a peak of about 430,000 in 2022. More recently, the number of employees in wood products manufacturing has declined. As of November 2025, the industry employs roughly 397,500 people.

Figure 2-2 depicts national unemployment trends in the wood products sector (2016-2025) using BLS Current Population Survey data. Unemployment peaked at about 7 percent in 2016 and hit a low of about 2 percent in 2018. Unemployment in the sector rose between 2018 and 2020, to about 4 percent, where it remained relatively stable until 2022. Since 2022, annual average unemployment in the wood products sector has ranged between 3 and 4.5 percent. Most recently, unemployment in the sector has been decreasing.

Figure 2-1 U.S. Wood Product Manufacturing Employment, NAICS 321, Seasonally Adjusted, 2016-2025

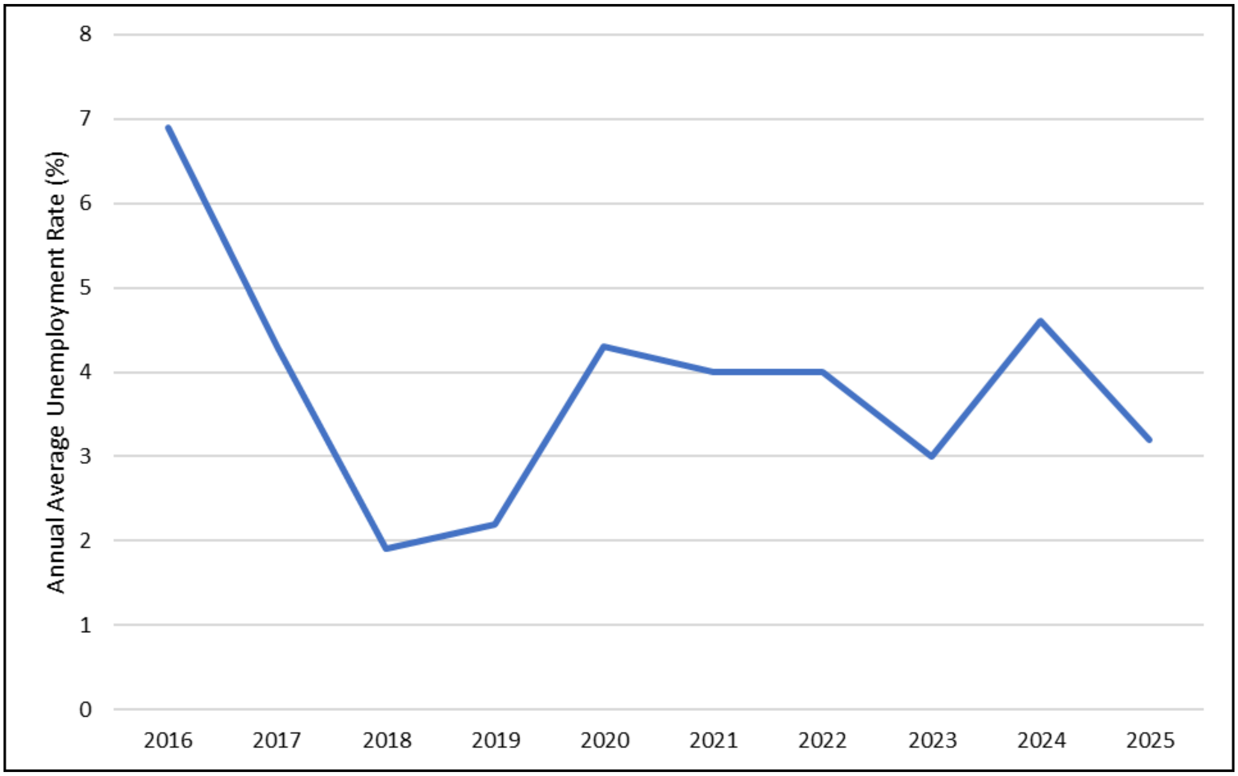

Figure 2-2 Wood Products Annual Average Unemployment Rate, 2016-2025

2.2.3 Capacity Utilization

Table 2-3 shows the capacity utilization rates for all manufacturing industries and for plywood and composite wood products industries from 2018 through 2024.

Table 2-3 Full Production Capacity Utilization Rates, Fourth Quarters, 2018-2024

NAICS	NAICS Description	2018	2019	2020	2021	2022	2023	2024	Change 2018 - 2024
31-33	All Manufacturing	74	71	75	75	74	73	71	-4%
3211	Sawmills and Wood Preservation	77	75	72	61	73	61	60	-21%
3212	Veneer, Plywood, and Engineered Wood Product Mfg.	76	78	75	82	70	69	66	-14%
3219	Other Wood Product Mfg.	73	74	79	79	65	69	71	-2%

Source: US Census Bureau. (2018, 2019, 2020, 2021, 2022, 2023, and 2024). Quarterly Survey of Plant Capacity Utilization [Fourth Quarters]. https://www.census.gov/programs-surveys/qpc/data/tables.html.

2.2.4 Industry Concentration

The standard view is that the higher the market concentration, the more changes in input price brought about by regulation will lead to output price rises due to lack of competition. Table 2-4 explores the concentration of each industry. In addition to the market share claimed by the largest companies (as measured by percentage of total sales, shipments, and revenue), it includes Herfindahl Hirschman Index (HHI) numbers by category. The U.S. Department of Justice generally considers markets in which the HHI is between 1,000 and 1,800 points to be moderately concentrated and anything greater to be highly concentrated.[5] By the definitions above, only softwood veneer and plywood manufacturing (321212) could be considered moderately concentrated based on 2022 data.

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[5] U.S. DOJ. (2024). Herfindahl-Hirschman Index. Accessed Jan. 30, 2026. https://www.justice.gov/atr/herfindahl-hirschman-index.

Table 2-4 Concentration Ratios by NAICS Code, 2012-2022

Year	No. of Companies in Industry	% Market Share for Largest Companies				Herfindahl-Hirschman Index (HHI)[a]
		4	8	20	50	
Sawmills (321113)						
2012	2,640	14	22	35	49	93
2017	2,545	21	31	41	54	159
2022	2,439	22	36	47	59	191
Hardwood Veneer and Plywood Manufacturing (321211)						
2012	216	36	49	68	86	543
2017	211	47	58	75	89	694
2022	174	40	54	74	90	579
Softwood Veneer and Plywood Manufacturing (321212)						
2012	69	50	65	90	100	906
2017	55	61	75	95	100	1,276
2022	52	53	69	93	D[b]	1,036
Engineered Wood Member Manufacturing (321215)[c]						
2012	92	51	66	82	97	1,198
2017	92	55	72	87	98	D[b]
2022	715	32	45	57	70	341
Reconstituted Wood Product Manufacturing (321219)						
2012	149	37	56	79	94	535
2017	134	47	69	86	97	764
2022	109	52	74	92	99	883
All Other Miscellaneous Wood Product Manufacturing (321999)						
2012	1,660	11	18	32	48	70
2017	2,647	10	17	30	45	63
2022	2,205	21	28	41	54	164

[a] HHI is based on the 50 largest companies for each NAICS code. [b] Withheld by the U.S. Census Bureau to avoid disclosing information about individual companies. [c] Industry definition changed between 2017 and 2022 to include truss manufacturing. Source: US Census Bureau. (2012, 2017, and 2022). Economic Census, Establishment and Firm Size Statistics for the U.S. [Tables EC1231SR2, EC1700SIZECONCEN, EC2200SIZECONCEN]. https://www.census.gov/programs-surveys/economic-census.html.

2.2.5 Costs of Production

Table 2-5 provides information on the overall value of sales, shipments, and revenue, as well as costs and their components by NAICS code for the years 2018 to 2021 (the last year for which complete data were available). These values were converted into 2024 dollars.

Table 2-5 Summary of Annual Sales, Shipments, Revenues and Costs, 2018-2021 (Thousands $2024)[a]

	2018	2019	2020	2021
Sawmills (321113)				
Value of Sales/Shipments/Revenue	36,847,154	31,908,636	35,789,900	36,411,428
Cost of Materials[b]	20,411,531	18,942,323	17,226,511	13,864,913
Capital Costs	1,651,362	1,579,790	1,316,883	1,634,626
Other Costs[c]	9,617,680	9,704,772	8,936,632	7,572,933
Ratio of Costs to Sales	86%	95%	77%	63%
Hardwood Veneer and Plywood Manufacturing (321211)				
Value of Sales/Shipments/Revenue	4,106,325	3,797,385	3,256,996	2,959,430
Cost of Materials[b]	2,631,959	2,501,551	2,041,216	1,796,641
Capital Costs	85,503	73,486	74,376	79,654
Other Costs[c]	1,144,766	1,107,148	966,285	810,125
Ratio of Costs to Sales	94%	97%	95%	91%
Softwood Veneer and Plywood Manufacturing (321212)				
Value of Sales/Shipments/Revenue	5,665,955	4,651,949	5,210,467	6,051,051
Cost of Materials[b]	3,207,394	2,822,559	2,670,117	2,379,911
Capital Costs	355,301	237,871	202,581	143,139
Other Costs[c]	1,456,599	1,461,780	1,417,047	1,190,696
Ratio of Costs to Sales	89%	97%	82%	61%
Engineered Wood Member Manufacturing (321215)				
Value of Sales/Shipments/Revenue	3,380,408	3,428,517	2,941,913	3,417,625
Cost of Materials[b]	2,377,098	2,005,211	1,886,928	2,112,171
Capital Costs	111,414	60,183	63,820	61,496
Other Costs[c]	734,259	723,506	629,071	632,850
Ratio of Costs to Sales	95%	81%	88%	82%
Reconstituted Wood Product Manufacturing (321219)				
Value of Sales/Shipments/Revenue	10,614,565	8,921,697	9,821,193	11,707,895
Cost of Materials[b]	5,154,161	5,852,358	5,062,280	5,089,114
Capital Costs	422,216	454,067	303,747	254,079
Other Costs[c]	2,310,532	2,320,919	2,048,744	1,832,780
Ratio of Costs to Sales	74%	97%	75%	61%
All Other Miscellaneous Wood Product Manufacturing (321999)				
Value of Sales/Shipments/Revenue	10,415,441	9,759,013	9,023,645	8,916,126
Cost of Materials[b]	5,329,380	4,907,497	4,695,076	4,678,323
Capital Costs	297,565	311,328	391,284	565,730
Other Costs[c]	3,292,041	3,481,953	3,102,738	2,927,010
Ratio of Costs to Sales	86%	89%	91%	92%

[a] Converted to 2024 dollars with NAICS 321 PPI. [b] Includes cost of materials & packaging, resales, fuel, electricity, and contract work. [c] Other costs include annual payroll, employer-provided fringe benefits, rental payments, and other operating expenses. Source: U.S. Census Bureau. (2022). 2018-2021 Annual Survey of Manufactures, Statistics for Industry Groups and Industries [Table AM1831BASIC01]. https://www.census.gov/data/tables/time-series/econ/asm/2018-2021-asm.html.

2.2.6 *Consumers and Uses*

Alderman (2022) offers information on consumption of wood products industry output by end use over the 2015 through 2019 period in his 2022 review of U.S. forest products.[6] These data are reported in Table 2-6.

Table 2-6 Wood Product Market Shares (%) in the United States by End Use, 2015-2019

Year	New Housing	Residential Repair & Remodeling	Nonresidential Construction	Furniture Manufacturing	Other Manufacturing	Packaging & Shipping	Total Reported Use	Other
Sawnwood[a]								
2015	25	32	10	3	7	17	95	5
2016	26	33	10	3	8	16	95	5
2017	28	33	10	3	8	14	95	5
2018	27	33	10	3	8	15	95	5
2019	27	33	9	3	8	16	96	4
Softwood Plywood								
2015	21	38	18	5	9	2	98	2
2016	23	39	17	5	8	2	98	2
2017	26	38	16	4	8	2	97	3
2018	25	38	16	4	8	2	97	3
2019	25	37	18	4	8	2	99	1
Oriented Strandboard								
2015	51	16	26	0	3	5	99	1
2016	53	16	25	0	3	4	99	1
2017	54	15	25	0	3	4	99	1
2018	52	15	23	0	3	6	96	4
2019	53	15	26	0	3	2	97	3
Nonstructural Panels[b]								
2015	18	14	9	22	23	1	88	12
2016	20	14	9	22	22	1	89	11
2017	21	14	9	23	22	1	89	11
2018	22	14	9	23	22	2	92	8
2019	22	14	9	23	22	2	92	8

[a] Includes sawn hardwood, softwood, glulam, and laminated veneer lumber. [b] Includes insulation board, hardboard, medium density fiberboard, hardwood plywood, and particleboard. Source: Alderman, D. (2022). U.S. Forest Products Annual Market Review and Prospects, 2015-2021. https://research.fs.usda.gov/treesearch/64129.

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[6] Alderman, D. (2022). U.S. Forest Products Annual Market Review and Prospects, 2015-2021 (FPL-GTR-289). https://research.fs.usda.gov/treesearch/64129.

2.2.7 Market Volumes, Imports, and Exports

Alderman (2022) also published data on market volumes, imports, and exports for the years 2018 through 2020 by product type.[7] Table 2 from that report has been reproduced below as Table 2-7. Information about market volumes organized by NAICS for the period from 2012 through 2017 is available in the EIA for the proposed amendments.[8]

Table 2-7 Wood Product Market Volumes by Product Type, 2018-2020[a]

	2018	2019	2020		2018	2019	2020
Sawn Softwood				***Sawn Hardwood***			
Production	59,344	59,781	61,021	Production	19,311	17,922	14,325
Imports	35,220	34,036	34,628	Imports	944	768	606
Exports	3,370	2,652	2,305	Exports	4,073	3,245	3,038
Consumption	91,193	91,165	93,344	Consumption	16,182	15,445	11,893
Oriented Strandboard				***Softwood Plywood***			
Production	13,389	13,588	13,459	Production	8,869	8,557	7,296
Imports	7,313	6,368	6,821	Imports	2,324	1,761	1,577
Exports	183	190	180	Exports	368	286	224
Consumption	20,519	19,766	20,100	Consumption	10,825	10,032	8,649
Hardboard				***Medium Density Fiberboard***			
Production	614	571	535	Production	3,977	3,857	3,700
Imports	253	182	201	Imports	2,413	2,221	2,160
Exports	186	203	220	Exports	514	312	415
Consumption	681	550	516	Consumption	5,876	5,766	4,665
Particleboard				***Hardwood Plywood***			
Production	5,838	5,589	5,605	Production	2,093	2,149	2,100
Imports	1,267	1,409	1,338	Imports	2,626	2,447	2,600
Exports	287	316	302	Exports	115	96	75
Consumption	6,818	6,682	6,641	Consumption	4,603	4,500	4,625

[a] All volumes are reported in thousand cubic meters except for insulation board, which is reported in thousand metric tons. Source: Alderman, D. (2022). U.S. Forest Products Annual Market Review and Prospects, 2015-2021. https://research.fs.usda.gov/treesearch/64129.

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[7] Alderman, D. (2022). U.S. Forest Products Annual Market Review and Prospects, 2015-2021 (FPL-GTR-289). https://research.fs.usda.gov/treesearch/64129.

[8] U.S. EPA. (2023). Economic Impact Analysis for the National Emission Standards for Hazardous Air Pollutants: Plywood and Composite Wood Products Amendments (EPA-452/R-23-008). Retrieved from docket: https://www.epa.gov/system/files/documents/2023-05/Proposed_PCWP_EIA.pdf.

2.2.8 *Prices*

Prices for wood products (NAICS 321) have increased over the past decade, but the process has been marked by high volatility Table 2-8 shows this pattern in detail, as well as detailed price data for each industry.

Table 2-8 Producer Price Indices (PPI) for PCWP Industries[a]

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2015 - 2024
Wood Product Manufacturing (321)											
PPI	100.0	100.8	105.1	112.0	109.3	119.4	154.6	168.4	148.6	146.9	
Annual % Change		0.8	4.3	6.6	-2.4	9.2	29.5	9.0	-11.8	-1.1	46.9
Sawmills (321113)											
PPI	100.0	101.3	108.3	115.9	104.2	124.3	169.4	164.8	122.9	122.3	
Annual % Change		1.3	6.8	7.0	-10.1	19.3	36.3	-2.7	-25.4	-0.5	22.3
Hardwood Veneer and Plywood (321211)											
PPI	100.0	104.0	106.0	112.9	113.3	114.5	125.2	142.9	144.0	140.5	
Annual % Change		4.0	2.0	6.5	0.3	1.1	9.3	14.2	0.8	-2.4	40.5
Softwood Veneer and Plywood (321212)											
PPI	100.0	91.3	99.5	117.0	97.2	111.3	175.9	173.3	133.1	128.0	
Annual % Change		-8.7	9.0	17.6	-16.9	14.5	58.1	-1.5	-23.2	-3.8	28.0
Engineered Wood Member Manufacturing (excluding trusses) (321215)											
PPI	100.0	100.7	104.1	112.6	110.6	109.1	168.3	228.7	212.0	203.4	
Annual % Change		0.7	3.4	8.2	-1.8	-1.3	54.3	35.9	-7.3	-4.0	103.4
Reconstituted Wood Product Manufacturing (321219)											
PPI	100.0	107.6	118.1	119.1	106.9	139.7	221.3	222.7	172.5	169.5	
Annual % Change		7.6	9.8	0.9	-10.2	30.7	58.4	0.6	-22.6	-1.8	69.5
All Other Miscellaneous Wood Product Manufacturing (321999)											
PPI	100.0	97.3	97.9	100.8	103.1	102.8	109.4	115.2	114.8	121.4	
Annual % Change		-2.7	0.6	3.0	2.3	-0.2	6.4	5.3	-0.4	5.7	21.4

[a] December 2015 = 100. Sources: US Department of Labor, Bureau of Labor Statistics. Industries at a Glance: Wood Product Manufacturing: NAICS 321. https://www.bls.gov/iag/tgs/iag321.htm.; US Department of Labor, Bureau of Labor Statistics. PPI Industry Data [Series PCU321113321113, PCU321211321211, PCU321212321212, PCU3212153212151, PCU321219321219, PCU3219993219990]. https://data.bls.gov/PDQWeb/pc.

3 ENGINEERING COST AND EMISSIONS IMPACT ANALYSIS

This engineering cost and emissions impact analysis presents the cost and emissions impact estimates for the regulatory options that EPA considered for existing and new major sources subject to the amendments to 40 CFR part 63, subpart DDDD, that this rule finalizes.

This impact analysis examines the effects of regulatory options for addressing PCWP process units with previously vacated no-control MACT floor determinations. This impact analysis also examines the effects of regulatory options for addressing previously unregulated HAP, including emissions of resin-related HAP (4,4-diphenylmethane diisocyanate (MDI)) and combustion-related HAP (non-Hg HAP metals using particulate matter (PM) as a surrogate, Hg emissions, acid gas (HCl, HF, CL_2), polycyclic aromatic hydrocarbons (PAHs), and dioxin/furan (D/F)).

The final regulatory option includes those standards that EPA is finalizing by this action. The EPA also considered a more stringent regulatory option with stricter standards than those finalized by this rulemaking but ultimately rejected it due to considerations about cost effectiveness, energy use, secondary emissions impacts, and effects on wastewater, solid waste, and labor. We present estimates of the cost and emissions impacts of these two options.[9] We did not identify a less stringent regulatory option.

3.1 GENERAL CONSIDERATIONS FOR THE IMPACT ANALYSIS

The EPA proposed MACT standards under 40 CFR part 63, subpart DDDD, for unregulated HAP on May 18, 2023 (88 FR 31856). Therefore, May 18, 2023, is the date that distinguishes between existing and new (or reconstructed) sources for purposes of applying the

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[9] Throughout the EIA use of "we", "us", or "our" is intended to refer to the EPA.

MACT standards being added to the PCWP NESHAP. We base the impact analysis for existing sources on sources currently subject to the PCWP NESHAP. Sources that commence construction or reconstruction after May 18, 2023, will be subject to the MACT standards for new or reconstructed sources, which may be more stringent than the MACT standards for existing sources.

The EPA completed a detailed analysis to develop new source projections over a period of five years when conducting the 2020 RTR for the PCWP NESHAP.[10] The new source projections developed for the 2020 RTR remain representative of the number of new and reconstructed affected sources expected to come online in the five-year period following the rulemaking applicability date (*i.e.*, from 2026 to 2031). For completeness of our rulemaking analyses, we estimated impacts for these projected new or reconstructed sources although the specific facilities where these processes may be located are presently unknown.

The EPA developed an inventory of existing and new major source facilities and process units at each facility to analyze the cost and emissions impacts of the different regulatory options. We estimated impacts at the level of the process unit and then aggregated to facility level and nationwide totals. Section 3.2 discusses the cost impacts, focusing on costs for each process unit before providing estimates of the total nationwide costs for each regulatory option. Section 3.3 presents estimates of total emissions impacts for the regulatory options.

The EPA estimated impacts for the 20-year period beginning in 2026 and ending in 2045. We selected 2026 as the initial analysis year because that is the year that new sources are assumed to begin operations and comply with the amendments. We then estimated cost and

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[10] Hanks, K., & Bradfield, J. (2019). Projections of the Number of New and Reconstructed Process Units for the Subpart DDDD Technology Review. Retrieved from docket: https://www.regulations.gov/document/EPA-HQ-OAR-2016-0243-0182.

emissions impacts over a 20-year period, ending in 2045, to account for a 20-year control equipment lifetime. We assume the number of existing and new sources remains constant during the analysis period. We present all costs in 2024 dollars.

3.2 COST IMPACTS

3.2.1 Lumber Kilns

Lumber kilns reduce the moisture content of lumber in preparation for different end uses, and the heating and drying of lumber that occurs inside lumber kilns can lead to emissions of HAP. HAP emitted by lumber kilns include both organic HAP as well as combustion-related HAP from direct-fired kilns.

The EPA proposed work practice standards to minimize the potential for HAP emissions from existing and new lumber kilns. These work practices address emissions of organic HAP that occur due to over-drying lumber as well as combustion-related HAP emissions from direct-fired kilns.

The EPA is now updating and finalizing work practice standards for existing and new lumber kilns. These work practice standards require developing and implementing operation and maintenance plans to maintain the integrity of lumber kiln internal air flow and heat distribution components and optimize lumber charging. These standards also require annual burner tune-up for direct-fired kilns to reduce the potential for combustion-related HAP emissions beyond the reduction in these emissions that results from reduced fuel consumption when minimizing lumber over-drying. In addition to these requirements, the EPA is finalizing a work practice option in which all kilns limit over-drying by either operating below a temperature limit, operating below a higher temperature limit and conducting moisture monitoring, or developing and implementing a site-specific plan with temperature limits and moisture monitoring. Finally, these standards define minimum kiln-dried lumber moisture content limits below which lumber is considered to be over-dried lumber for all kilns for purposes of the PCWP NESHAP.

The costs of the final work practice standards for existing and new lumber kilns include one-time labor costs to develop the lumber kiln operation and maintenance plan and conduct training as well as some non-labor contingency for initial kiln maintenance, data acquisition system improvements, and development of the record system. For direct-fired lumber kilns, initial costs also include an initial set-up for a boiler tune-up. We discuss burner tune-up costs in more detail in Section 3.2.4.6. The costs of the final work practice standards for all existing and new lumber kilns also include annual costs comprised of operation and maintenance for all kilns, annual burner tune-ups for direct-fired kilns, and development and implementation of one of the three work practice options regarding temperature limits and moisture content monitoring.

We applied the one-time cost and annual costs of the work practice standards for each kiln in the inventory. We assumed work practice costs for the temperature limit option for kilns operating below the maximum dry bulb temperature specified in the work practice. We assigned the hybrid work practice cost for kilns reporting use of in-kiln lumber moisture monitoring methods in the 2017 ICR if they met the hybrid temperature limit. We assumed all other kilns will require a site-specific plan for temperature and lumber moisture monitoring.

The EPA did not consider add-on controls for lumber kilns to be a viable option for reducing HAP emissions, and no emissions reduction measures more stringent than the proposed work practice standards were identified.

3.2.2 Process Units with Previous "No Control" MACT Determinations

This section includes a written summary of the costs associated with the amendments addressing HAP emissions from process units that were previously regulated by "no control" MACT determinations in the 2004 PCWP NESHAP which were subsequently remanded and vacated in 2007.

3.2.2.1 Log Vats

Log vats condition logs after debarking and before they are cut into veneer or wood strands. Hot water vats in which logs are immersed are often open to the atmosphere. In log steaming or "chest" vats, logs are placed in the vat in batches, the door is closed, and steam (which condenses in the vat) along with hot water sprays condition the logs for a specified time before the logs are removed for veneer production.

The EPA considered a work practice standard for log vats at existing and new sources that requires facilities to operate each vat using a site-specific target log temperature that does not exceed 212°F and to reduce the potential for fugitive emissions by either covering at least 80 percent of the vat hot water surface area for soaking vats or keeping doors closed while steam or hot water showers are applied inside log steaming vats. The EPA is finalizing the proposed work practice requiring existing and new sources to operate vats using a site-specific log temperature that does not exceed 212°F but is not finalizing the work practice related to fugitive emissions. This change from the proposed rule eliminates the distinction between hot water and steaming vats.

Initial and continuous compliance with the final work practice for existing and new log vats will be demonstrated through continuous temperature monitoring, recordkeeping, and reporting that reflects adherence to the work practice conditions. Monitoring costs include initial capital costs for a continuous parameter monitoring system (CPMS) for one parameter (*i.e.*, temperature) as well as annual costs consisting of monitoring system operation and maintenance, reporting and recordkeeping, and property taxes, insurance, and administrative costs. Additional costs include one-time labor costs for reviewing operations to describe how each log vat meets the work practice standards in the notification of compliance status (NOCS) as well as annual labor costs for semi-annual reporting of ongoing compliance with the work practice standards.

No regulatory options more stringent than the work practice standards were identified for existing and new log vats.

3.2.2.2 Hardboard Process Units

In this section, we discuss the cost impacts of regulatory options for a batch stand-alone digester, fiber washer, hardboard press predryer, and fiberboard mat dryer that are not currently subject to the PCWP NESHAP.

3.2.2.2.1 Stand-Alone Digester and Fiber Washer

Stand-alone digesters steam or water soak wood chips so that they may be easily rubbed apart or ground into fibers in atmospheric refiners that operate downstream from the digesters. Fiber washers are units in which water-soluble components of wood (hemicellulose and sugars) that have been produced during digesting and refining are removed from the wood fiber before the fiber is used in fiberboard or hardboard production. In a fiber washer, wet fiber leaving a refiner is further diluted with water and passed over a filter, leaving the cleaned fiber on the surface.

The EPA proposed and is updating and finalizing work practice standards for existing and new stand-alone digesters and fiber washers. The EPA is finalizing a proposed work practice standard for reducing potential for HAP emissions from stand-alone digesters that require clean steam to be used in the digesters and prohibits addition of HAP-containing or wood pulping chemicals to the digestion process. For fiber washers, the EPA considered a work practice standard that requires using fresh water for washing and processing fiber without addition of wood pulping or HAP-containing chemicals; however, based on the technical infeasibility of complying with the fresh water washing requirement, the EPA is not finalizing the proposed standard requiring use of fresh water and is only finalizing the work practice requiring the processing of fiber without addition of wood pulping or HAP-containing chemicals. Initial and continuous compliance with the work practices must be demonstrated through recordkeeping.

At the time of the proposal, only one wet/dry process hardboard facility operated a batch stand-alone digester and fiber washer. That one facility has since closed, and no new PCWP affected sources are expected to use stand-alone digesters or fiber washers. Therefore, there are no costs associated with the final work practice standards requiring use of clean steam in existing stand-alone digesters and no addition of HAP-containing or wood pulping chemicals in existing stand-alone digesters and fiber washers.

No regulatory options more stringent than the work practices for existing and new stand-alone digesters and fiber washers were identified.

3.2.2.2.2 Existing Fiberboard Mat Dryer Heated Zones and Hardboard Press Predryers

Fiberboard mat dryers are conveyor-type dryers that dry wet-formed fiber mats, and press predryers are used in the wet/dry hardboard process to remove additional moisture from the hardboard mat after it exits the fiberboard mat dryer and before the mat enters the hardboard press. The 2004 PCWP NESHAP contains HAP emission limits for fiberboard mat dryer heated zones and hardboard press predryers at new sources; however, these types of dryers at existing sources are unregulated. Therefore, the EPA proposed and is finalizing numeric standards for organic HAP emissions from existing source fiberboard mat dryers and hardboard press predryers.

At the time of the proposal, only one existing source operated a fiberboard mat dryer and hardboard press predryer, and HAP emissions from these process units were uncontrolled. Because there was only one existing source operating an uncontrolled fiberboard mat dryer and hardboard press predryer, the EPA proposed and is finalizing the MACT floor emission level for each dryer based on the upper limit of HAP test data collected through the 2022 CAA section 114 survey which corresponds to the performance level of the process units.

Since the proposal, the one source operating a fiberboard mat dryer and hardboard press predryer has closed. Therefore, there are no costs associated with finalizing the standards for organic HAP emissions from existing source fiberboard mat dryers and hardboard press predryers.

The EPA considered a regulatory option more stringent than the MACT floor in which an RTO would be used to reduce HAP emissions from the fiberboard mat dryer heated zones and the hardboard press predryer to meet emissions limits in Table 1B to subpart DDDD of 40 CFR part 63. The EPA considered both dryers together because using one oxidizer to treat emission streams from both dryers would be more cost effective than using two separate HAP control devices. Because the one source operating a fiberboard mat dryer and hardboard press predryer at the time of the proposal has since closed, there are no costs associated with the more stringent regulatory option. The EPA is finalizing the proposed MACT standard rather than the beyond the floor approach.

3.2.2.3 Atmospheric Refiners

Atmospheric refiners operate with continuous infeed and outfeed of wood material and under atmospheric pressure for refining (rubbing, grinding, or milling) wood material into fibers or particles used in particleboard or dry formed hardboard production. Atmospheric refiners are further characterized based on their placement before or after dryers in the PCWP production process. “Post-dryer atmospheric refiners” process wood that has been dried onsite in a dryer while “multipurpose atmospheric refiners” encompass all other atmospheric refiners. Based on information from the 2017 ICR and more recent updates, the EPA estimates that there are 5 existing post-dryer atmospheric refiner systems controlled by a baghouse for dust collection and 25 existing multipurpose atmospheric refiner systems controlled by cyclones, baghouses, and oxidizers.

3.2.2.3.1 Post-Dryer Atmospheric Refiners

The EPA proposed a MACT floor for organic HAP emissions from existing sources based on the average of HAP emissions data provided for two of the existing post-dryer atmospheric refiner system and a MACT floor for organic HAP emissions from new sources based on the best performing system. The EPA is finalizing the organic HAP MACT floors for post-dryer atmospheric refiners as proposed.

The EPA anticipates that the final organic HAP MACT floor for existing post-dryer atmospheric refiners could be met without additional controls, so the EPA does not expect associated incremental control costs. Therefore, the costs associated with meeting the standard are emissions testing and reporting and recordkeeping costs. We based the cost of emissions testing on EPA Method 320 and NCASI A105.1 emissions testing methods. We estimated reporting and recordkeeping costs assuming a total of 80 hours of labor at the composite wage rate for compiling data and entering and verifying information for semiannual reports.

A more stringent regulatory option for existing post-dryer atmospheric refiners would further reduce HAP emissions using add-on HAP controls such as RTOs. Therefore, the costs of this more stringent regulatory option include the cost of RTO installation and RTO operation and maintenance costs in addition to monitoring and emissions testing costs. The cost of RTO installation and operation and maintenance varies with the number of post-dryer atmospheric refiners in the system. The greater the number of atmospheric refiners that make up the system, the greater the RTO-related costs. Monitoring costs include an initial capital investment in a CPMS for monitoring RTO temperature and annual costs consisting of monitoring system operation and maintenance costs, monitoring system reporting and recordkeeping costs, and property taxes, insurance, and administrative costs. We estimated emissions testing costs based on EPA Method 320 and NCASI A105.1 emissions testing methods. The EPA does not expect any new post-dryer atmospheric refiner systems.

3.2.2.3.2 Multipurpose Atmospheric Refiners

Organic HAP emissions data were available from the 2022 CAA section 114 survey testing for five multipurpose atmospheric refiner systems, including three systems controlled by oxidizers and two systems controlled by baghouses. Using data for the five systems, the EPA proposed an organic HAP MACT floor for existing and new multipurpose atmospheric refiner systems. The EPA is finalizing these standards as proposed. Based on the average performance level for existing multipurpose atmospheric refiners, the EPA estimates that existing sources will meet the organic HAP MACT floor without additional controls.

Therefore, the costs associated with meeting the standards for existing sources consist of emissions testing costs and annual reporting and recordkeeping costs. We estimated the cost of emissions testing based on EPA Method 320 and NCASI A105.1 emissions testing methods. We estimated reporting and recordkeeping costs assuming a total of 80 hours of labor at the composite wage rate for compiling data and entering and verifying information for semiannual reports.

A more stringent regulatory option would require existing multipurpose atmospheric refiners to meet the emission limits in Table 1B to subpart DDDD of 40 CFR part 63. Under this option, the EPA expects 21 of the 25 existing multipurpose atmospheric refiner systems would install RTOs to reduce HAP emissions. Therefore, the cost of this more stringent regulatory option includes the cost of RTO installation and associated operation and maintenance costs which would vary with the number of atmospheric refiners in the system, as well as monitoring and emissions testing costs. Monitoring costs include an initial capital investment in a CPMS for monitoring RTO temperature and annual costs consisting of monitoring system operation and maintenance costs, monitoring system reporting and recordkeeping costs, and property taxes, insurance, and administrative costs. We estimated emissions testing costs based on EPA Method 320 and NCASI A105.1 emissions testing methods.

The EPA expects one new multipurpose atmospheric refiner system within the next five years that consists of four refiners. The EPA expects HAP emissions from this new system to be controlled by installation and operation of a baghouse and RTO. Therefore, the costs to comply with the standards for the new system include installation and operation and maintenance costs for an RTO to control HAP emissions for four multipurpose atmospheric refiners as well as monitoring and emissions testing costs. Monitoring costs include an initial capital investment in a CPMS for monitoring RTO temperature and annual costs consisting of monitoring system operation and maintenance costs, monitoring system reporting and recordkeeping costs, and property taxes, insurance, and administrative costs. Emissions testing costs were based on EPA Method 320 and NCASI A105.1 emissions testing methods.

Because the new source standard in the final regulatory option already requires add-on HAP controls, the EPA did not identify regulatory options more stringent than the MACT floor for new sources.

3.2.2.4 Resinated Material Handling Process Units

Resinated material handling (RMH) process units within the PCWP affected source include resin tanks, softwood and hardwood plywood presses, engineered wood products presses and curing chambers, blenders, formers, finishing saws, finishing sanders, panel trim chippers, reconstituted wood product board coolers (at existing affected sources), hardboard humidifiers, and onsite wastewater treatment operations specifically associated with PCWP manufacturing. These process units handle resin or resinated wood material downstream of the point in the PCWP process where resin is applied.

As explained in the proposal, RMH process units are not designed and constructed in a way that allows for HAP emissions capture or measurement. Consequently, the EPA proposed work practice standards aiming to reduce or eliminate emissions of HAP through process changes or substitution of materials. These standards include (1) using only a non-HAP resin, or (2) using a resin with a maximum true vapor pressure of less than or equal to 5.2 kilopascals (kPa), which is equal to 0.75 pounds per square inch absolute (psia), or (3) using a combination of resins meeting (1) or (2). Facilities with RMH process units would also be required to process wood material that was purchased pre-dried to a moisture content of no more than 30 percent (weight percent, dry basis) or that has been dried in a dryer located at the PCWP facility, with exceptions to the dried wood requirement for wet formers and wastewater operations. The EPA also proposed standards for wastewater operations associated with PCWP manufacturing.

The EPA is updating and finalizing work practice standards for new and existing sources requiring use of non-HAP resins, which the EPA has defined as "a resin that contains less than 0.1 percent by mass of formaldehyde and less than 1.0 percent by mass each of phenol, methanol, and MDI," or amino/phenolic resins that are not non-HAP resins and MDI resins that meet a tiered vapor pressure limit of 5.2 kPa (0.75 psia) when stored in resin tanks with capacity greater than or equal to 40,000 gallons and 13.1 kPa (1.9 psia) when stored in one or more resin tanks with capacity less than 40,000 gallons. The EPA is also finalizing work practice standards for new and existing sources requiring processing of dried wood in resinated material handling process units. The EPA is not finalizing the proposed standards for wastewater operations associated with PCWP manufacturing.

The costs associated with the resin-related standards for RMH units include initial costs for reviewing the HAP content of resins used and preparing the NOCS documentation, annual costs related to semi-annual reporting and recordkeeping, and the costs of resin changes needed to comply with the standards. We estimated the one-time, initial costs for reviewing the HAP content of resins used and preparing the NOCS to be $13,309 assuming 80 hours labor per facility at the composite wage rate. We estimated the annual cost for semi-annual reporting of ongoing compliance with the standard to be $665/year assuming two hours labor per semi-annual report per PCWP facility at the composite wage rate. We estimated the annual cost of resin changes needed to meet the standards to be $0.20 per pound of resin used per year to adjust the resin HAP content, and $11 per thousand square feet (MSF) produced on a 3/8" basis for adjustments to production processes (*e.g.*, changes in press temperature or time). We based these estimates loosely on the magnitude of estimates for resin changes to meet the CARB and TSCA rules.[11, 12]

The costs associated with the standard for processing dried wood include a one-time, initial cost to review operations and include the RMH process units in the NOCS, and annual costs for semi-annual reporting and recordkeeping. We estimated the cost of reviewing operations to address processing of dried wood in the NOCS to be $6,655 per facility assuming 40 hours labor at the composite wage rate. We estimated the annual cost for semi-annual reporting of ongoing compliance with the standard to be $665/year assuming two hours labor per semi-annual report per PCWP facility at the composite wage rate.

The EPA did not identify regulatory options more stringent than the RMH process unit work practices for resin tanks, softwood and hardwood plywood presses, engineered wood products presses, and curing chambers, blenders, formers, finishing saws, finishing sanders, panel trim chippers, or hardboard humidifiers at new or existing affected sources, or for reconstituted wood products board coolers at existing affected sources. Reconstituted wood products board coolers at new affected sources are already subject to standards under the PCWP NESHAP.

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[11] CARB. (2007). Proposed Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products. Staff Reprt: Initial Statement of Reasons for Proposed Rulemaking. Appendix VIII. Retrieved from docket: https://www.regulations.gov/document/EPA-HQ-OAR-2016-0243-0348.

[12] U.S. EPA. (2016a). Economic Analysis of the Formaldehyde Standards for Composite Wood Products Act Final Rule. Retrieved from docket: https://www.regulations.gov/document/EPA-HQ-OPPT-2016-0461-0037.

3.2.3 Resin-Related HAP

This section includes a written summary of the costs associated with the amendments addressing emissions of resin-related HAP emitted by PCWP process units.

3.2.3.1 MDI Emissions

The EPA identified three types of process units that are currently subject to HAP standards in the PCWP NESHAP but were evaluated further for MDI emissions. These include miscellaneous coating operations, tube dryers that blow-line blend MDI resin, and reconstituted wood products presses. We discuss the costs associated with regulatory options for MDI from these processes in this section.

3.2.3.1.1 Miscellaneous Coating Operation Using MDI

The EPA proposed and is finalizing numerical standards for MDI emissions from miscellaneous coating operations in which MDI moisture sealants are applied to engineered wood products such as parallel strand lumber or laminated veneer lumber. As part of the 2022 CAA section 114 survey, the EPA collected MDI emissions data from one MDI moisture sealant spray booth at an engineered wood products facility. The EPA used the emissions test data from this one facility to propose a MACT floor limit for existing and new sources. The EPA is now finalizing the MACT floor limits as proposed.

The cost impacts associated with the miscellaneous coating MDI emission limit consist of emissions testing costs, spray booth filter replacement costs, and reporting and recordkeeping costs. We estimated the costs of initial and five-year repeat emissions testing based on EPA Method 326. Ongoing compliance costs also include annual spray booth filter replacement costs of $6,400/year and the costs of reporting and recordkeeping (*e.g.*, amount of sealant applied and wood product throughput). We estimated annual reporting and recordkeeping costs to be $1,330/year based on 8 hours of labor per year at the composite wage rate.

The EPA did not identify regulatory options more stringent than the MDI MACT floor for existing and new miscellaneous coating operations, and no new sources are projected in the next five years.

3.2.3.1.2 Tube Dryers Blow-Line Blending MDI

Tube dryers reduce moisture from wood furnish used in the manufacture of composite wood products. Primary tube dryers are single-stage tube dryers or the first stage of a multi-stage tube dryer in which most of the moisture from wood furnish is removed. Secondary tube dryers are the second or subsequent stages following the primary stage of a multi-stage tube dryer.

Primary tube dryers often incorporate blow-line blending in which resin is added to wood furnish as it enters the primary tube dryer. The resin and wood furnish mix with the turbulent conditions in the primary tube dryer as the wood furnish is dried. Within the PCWP source category, five primary tube dryer systems incorporate blow-line blending using MDI resin to produce medium density fiberboard. In addition, three secondary tube dryers follow primary tube dryers that blow-line blend MDI resin. These primary and secondary tube dryers are often co-controlled. Primary tube dryers may also be co-controlled with a reconstituted wood products press.

As part of the 2022 CAA section 114 survey, the EPA collected MDI emissions data from one primary tube dryer system that blow-line blends MDI and is co-controlled with a press using an RTO. The EPA used emissions data to propose numeric MACT standards for MDI emissions from existing and new primary and secondary blow-line blend tube dryers and blow-line blend tube dryers and press combinations. The EPA is now finalizing the proposed MDI MACT floor standards.

Because all existing tube dryer systems operate HAP emissions controls, the EPA expects that they will all meet the MDI MACT floor based on the average MDI emissions from the comparable unit tested. Additionally, because the EPA expects HAP emissions controls to be installed for tube dryer systems that blow-line blend MDI even in the absence of the standards finalized by this rule, we did not estimate incremental control cost for new systems. Therefore, the cost impacts associated with the tube dryer MDI emission limit consist only of emissions testing costs. We estimated emissions testing costs for MDI based on EPA Method 326.

The EPA did not identify regulatory options more stringent than the MACT floor for existing or new tube dryers that blow-line blend MDI.

3.2.3.1.3 Reconstituted Wood Products Presses Using MDI

The EPA proposed and is finalizing separate numeric standards for existing and new reconstituted wood product presses that produce oriented strandboard and reconstituted wood product presses that produce particleboard or medium density fiberboard and which are not co-controlled with tube dryer systems. The EPA developed separate standards because the smaller wood fibers or particles used in particleboard or medium density fiberboard presses have greater overall surface area that is coated with MDI resin than wood strands and therefore different potential for MDI emissions.

The EPA is finalizing an MDI MACT floor for existing and new oriented strandboard reconstituted wood products presses. All existing oriented strandboard presses have HAP controls that the EPA expects will meet this emission limit based on the average MDI emissions from comparable process units tested. Therefore, the cost impacts for existing oriented strandboard presses associated with the MDI MACT floor are emissions testing costs. We estimated emissions testing costs based on EPA Method 326.

The EPA expects two new oriented strandboard reconstituted wood products presses within the next five years. The EPA expects these sources to install HAP controls in the absence of the standards finalized by this rule that will meet the MDI MACT floor for new sources. Therefore, the incremental costs associated with the standards are emissions testing costs. We estimated emissions testing costs based on EPA Method 326.

The EPA is finalizing numeric standards for existing particleboard and medium density fiberboard reconstituted wood products presses. The MACT floor for existing particleboard and medium density fiberboard reconstituted wood products presses that are not co-controlled with a tube dryer is expected to be met by the presses with HAP controls in place based on the average MDI emissions from similarly controlled units. Therefore, the EPA does not expect incremental control costs for units that are co-controlled with a tube dryer or otherwise already have HAP controls.

It is currently unknown whether existing particleboard presses at two facilities that meet the PCWP production-based compliance option (provided in Table 1A to Subpart DDDD) using pollution prevention measures will be impacted by the MDI MACT floor. In the absence of MDI emissions data for these presses, we assumed that a HAP control device may be needed to meet the MDI MACT floor. For one of the facilities, capital and annual costs associated with RTO control were estimated using the production-based compliance option. Capital costs were estimated assuming a permanent total enclosure. The enclosure costs were taken from a report developed for the initial PCWP NESHAP and escalated to 2024 dollars.[13] The other facility already has a press biofilter installed, but the biofilter was not in use at the time of the 2017 ICR. For this facility, we estimated that operation of the biofilter could be resumed to reduce HAP emissions including MDI. We estimated the incremental costs for resuming operation of the biofilter to be $382,665/yr based on biofilter operation and maintenance costs from the 2017 ICR (which were scaled to 2024) and $11,308 in monitoring costs for two air pollution control device parameters. Monitoring costs include operation and maintenance, reporting and recordkeeping, and property taxes, insurance, and administrative costs. Additional cost impacts for all existing particleboard and medium density fiberboard reconstituted wood products presses that are not co-controlled with a tube dryer include emissions testing costs. We estimated emissions testing costs based on EPA Method 326.

The EPA is finalizing a MACT floor for new particleboard and medium density fiberboard reconstituted wood products presses. The EPA expects two new particleboard and medium density fiberboard reconstituted wood product presses within the next five years. The EPA expects these sources to install HAP controls in the absence of the standards finalized by this rule that will meet the numeric emissions limits for new sources. Therefore, the incremental costs associated with the standards are emissions testing costs. We estimated emissions testing costs based on EPA Method 326.

The EPA did not identify regulatory options more stringent than the MDI MACT floor for reconstituted wood products presses.

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[13] U.S. EPA. (2000c). Background Information Document for Proposed Plywood and Composite Wood Products NESHAP (EPA-453/R-01-004). Retrieved from docket: https://www.regulations.gov/document/EPA-HQ-OAR-2016-0243-0103.

3.2.4 Combustion-Related HAP

This section includes a written summary of the costs associated with the amendments addressing emissions of combustion-related HAP emitted by PCWP process units.

3.2.4.1 PCWP Wood-Fired Dryer Non-Mercury HAP Metal and PM

The EPA proposed and is updating and finalizing numeric standards for emissions of filterable PM as a surrogate for emissions of non-Hg HAP metal from combustion in existing and new direct wood-fired PCWP dryers. Filterable PM commonly serves as a surrogate for HAP metals in particulate form, including antimony, arsenic, beryllium, cadmium, chromium, cobalt, lead, manganese, nickel, and selenium. Air pollution control devices that reduce PM also reduce non-Hg HAP metals in particulate form.

We estimated cost impacts of the non-Hg HAP metal MACT options for existing and new sources for direct wood-fired rotary strand dryers, green rotary dryers, dry rotary dryers, primary and secondary tube dryers, and softwood veneer dryer heated zones. The EPA compared the baseline PM performance level for each PCWP dryer to the numeric PM standard (or more stringent option, if applicable). In cases where the EPA expected that the PM standards (or options) will not be met, we considered the actual or estimated performance of the dryers to estimate whether the dryer system will require an upgrade to meet the regulatory option. We estimated control costs if we expected a control technology upgrade will be needed. We also estimated monitoring, emissions testing, and associated reporting and recordkeeping costs.

3.2.4.1.1 Rotary Strand Dryers

Rotary strand dryers use a rotating drum to remove moisture from wood strands used in the production of oriented strandboard, laminated strand lumber, and other wood strand-based products. Wood strands tumble through the drum while hot combustion gases flow through to evaporate water.

Most of the 25 direct wood-fired rotary strand dryer systems at major sources in the U.S. operate with PM and HAP control technology (*e.g.*, WESP and RTOs). The use of WESPs for PM control upstream of HAP controls on PCWP rotary strand dryers is prevalent because the high moisture exhaust stream and nature of the particulate originating from dryers (*e.g.*, sticky, flammable) is not well-suited for other methods of PM control (*e.g.*, baghouses).

To estimate cost impacts for existing direct wood-fired rotary strand dryers, where the EPA expected a PM control upgrade will be needed to meet the PM MACT floor, we assigned the costs of a new WESP system where no WESP was in place (*e.g.*, for dryers with an electrified filter bed or multiclone preceding an RTO). If we estimated that an existing WESP required an update, then we estimated the incremental capital cost, annualized capital, and operating costs and operating factors (*e.g.*, increased electric or water use) will be one-third that of a comparable new WESP.

Additional cost impacts for existing direct wood-fired rotary strand dryers include costs related to monitoring and emissions testing. Monitoring costs include an initial capital investment and annual costs that consist of monitoring system operation and maintenance costs, monitoring system reporting and recordkeeping costs, and property taxes, insurance, and administrative costs. We estimated monitoring costs for each rotary strand dryer system based on costs for a continuous parameter monitoring system (CPMS) for monitoring and recording up to two processes or control device parameters. We estimated emissions testing costs based on EPA Method 5. We describe monitoring and emissions testing costs in more detail in Section 3.1.5.

The EPA did not identify regulatory options more stringent than the MACT floor for existing direct wood-fired rotary strand dryers.

The EPA projected two new oriented strandboard production facilities with direct wood-fired rotary strand dryer systems will be constructed within five years. The PM MACT floor for new direct wood-fired rotary strand dryer systems is achievable with a very well-performing WESP/RTO system. Because a WESP/RTO system is the most likely control system to be installed in the absence of the standards finalized by this rule, the incremental control technology cost attributable to the standards finalized by this rule are for an upgraded WESP. As noted above, for an upgraded WESP, we estimated the added incremental capital cost, annualized capital, and operating costs and operating factors (*e.g.*, increased electric or water use) to be one-third the cost of a comparable new WESP that would likely have been installed in the absence of the PM MACT floor.

Additional cost impacts for new direct wood-fired rotary strand dryers include costs related to monitoring and emissions testing. Monitoring costs include an initial capital investment and annual costs that consist of monitoring system operation and maintenance costs, monitoring system reporting and recordkeeping costs, and property taxes, insurance, and administrative costs. We estimated monitoring costs for each rotary strand dryer system based on costs for a CPMS for monitoring and recording up to two processes or control device parameters. We estimated emissions testing costs based on EPA Method 5.

The EPA did not identify regulatory options more stringent than the MACT floor for new (or reconstructed) direct wood-fired rotary strand dryers.

3.2.4.1.2 Green Rotary Dryers

Green rotary dryers are rotating drum dryers that dry wood particles or fibers with an inlet moisture content of greater than 30 percent (by weight, dry basis) at any dryer inlet temperature or operate with an inlet temperature of greater than 600°F with any inlet moisture content.

The six direct wood-fired green rotary dryer systems in the U.S. already operate with PM and HAP control technology. Five of the six existing green rotary dryer systems operate with a WESP/RTO or equivalent. The remaining system operates with a dry ESP/RTO. The EPA estimated that all the existing direct wood-fired green rotary dryers will meet the PM MACT floor level without additional controls.

The costs associated with the standards based on the PM MACT floor for existing direct wood-fired green rotary dryers consist of monitoring and emissions testing costs. Monitoring costs include an initial capital investment and annual costs that consist of monitoring system operation and maintenance costs, monitoring system reporting and recordkeeping costs, and property taxes, insurance, and administrative costs. We estimated monitoring costs for five of the six existing green rotary dryer systems based on costs for a CPMS for monitoring and recording up to two process or control device parameters. We estimated monitoring costs for the system controlled with a dry ESP/RTO based on costs for a CPMS for one parameter. We estimated emissions testing costs based on EPA Method 5.

The EPA did not identify regulatory options more stringent than the MACT floor for existing direct wood-fired green rotary dryers.

The EPA projected one new direct wood-fired green rotary dryer with a WESP/RTO will be constructed within five years. The EPA expects the new dryer will meet the PM MACT floor using the same control technology that would have been installed in the absence of the PM standard. Therefore, we estimated no incremental control equipment costs for the new green rotary dryer.

The costs associated with the standards based on the PM MACT floor for new direct wood-fired green rotary dryers consist of monitoring and emissions testing costs. Monitoring costs include an initial capital investment and annual costs that consist of monitoring system operation and maintenance costs, monitoring system reporting and recordkeeping costs, and property taxes, insurance, and administrative costs. We estimated monitoring costs for six of the seven existing green rotary dryer systems based on costs for a CPMS for monitoring and recording up to two process or control device parameters.

The EPA did not identify regulatory options more stringent than the MACT floor for new (or reconstructed) direct wood-fired green rotary dryers.

3.2.4.1.3 Dry Rotary Dryers

Dry rotary dryers are rotating drum dryers that dry wood particles or fibers with a maximum inlet moisture content of less than or equal to 30 percent (by weight, dry basis) and operate with a maximum inlet temperature of less than or equal to 600 °F.

The MACT floor for existing direct wood-fired dry rotary dryers is based on the current level of control which is a mechanical collection (*e.g.*, multiclone). The EPA expects all three of the existing dry rotary dryer systems in the U.S. to meet the PM MACT floor without incremental control technology costs, and no new dry rotary dryers are projected to be constructed in the next five years.

The costs associated with the standards based on the PM MACT floor for existing direct wood-fired dry rotary dryers consist of monitoring, emissions testing, and reporting and recordkeeping costs. Monitoring costs include an initial capital investment and annual monitoring system operation and maintenance costs. We estimated monitoring costs d based on costs for a continuous opacity monitoring system (COMS). We estimated emissions testing costs based on EPA Method 5. We estimated annual reporting and recordkeeping costs separately from monitoring costs. The annual reporting and recordkeeping costs consist of labor costs for compiling data and entering and verifying information in semiannual reports. We estimated labor costs for reporting and recordkeeping based on a composite of technical, management, and clerical wage rates plus fringe benefits and overhead.

The EPA considered a more stringent regulatory option to achieve further PM reduction from existing direct wood-fired dry rotary dryers consisting of using a WESP/RTO control system. The WESP/RTO technology would enable the dry rotary dryers to meet the same PM limits as required for green rotary dryers. Costs of the more stringent regulatory option include WESP/RTO installation and operation and maintenance costs.

Under the more stringent regulatory option, additional cost impacts for existing direct wood-fired dry rotary dryer systems include monitoring and emissions testing costs. With WESP/RTO control technology, monitoring costs would no longer be based on a COMS but on a CPMS for two parameters. Monitoring costs would include an initial capital investment and annual costs that consist of monitoring system operation and maintenance costs, monitoring system reporting and recordkeeping costs, and property taxes, insurance, and administrative costs. Emissions testing costs would be the same as under the policy option and be based on EPA Method 5.

The EPA does not expect new direct wood-fired dry rotary dryers in the next five years.

3.2.4.1.4 Primary and Secondary Tube Dryers

The primary tube dryer PM MACT standards also apply for secondary tube dryers because these dryers share the same emission points.

The EPA expects all 11 of the existing direct wood-fired tube dryer systems in the U.S. to meet the PM MACT floor level using the control technology already installed. Therefore, we estimated the incremental costs associated with the standards based on the PM MACT floor for existing direct wood-fired primary and secondary tube dryers based on monitoring, emissions testing, and reporting and recordkeeping costs. Monitoring costs for eight of the 11 existing direct wood-fired tube dryer systems include initial capital investment in a CPMS for two air pollution control device parameters and annual costs consisting of operation and maintenance, reporting and recordkeeping, and property taxes, insurance, and administrative costs. Monitoring costs for one of the tube dryer systems are based on a CPMS for one air pollution control device parameter. We expect two of the 11 systems to incur monitoring costs based on initial capital investment in a COMS and annual monitoring system operation and maintenance costs. We estimated reporting and recordkeeping costs for the two existing tube dryer systems monitored by a COMS separately based on labor costs for compiling data and entering and verifying information in semiannual reports. We estimated reporting and recordkeeping labor costs based on a composite of technical, management, and clerical wage rates plus fringe benefits and overhead. We expect all existing direct wood-fired primary and secondary tube dryer systems to incur emissions testing costs based on EPA Method 5.

The EPA did not identify regulatory options more stringent than the PM MACT floor for existing direct wood-fired primary and secondary tube dryers.

The EPA projected one new direct wood-fired primary tube dryer with a scrubber or WESP and RTO will be constructed within five years. No new secondary tube dryers were projected. The EPA expects the projected primary tube dryer will meet the PM MACT floor using the same control technology that would have been installed in the absence of the PM standard. Therefore, we estimated no incremental control device installation or operation and maintenance costs for the new primary tube dryer.

Additional cost impacts for the new direct wood-fired primary tube dryer system include costs related to monitoring and emissions testing. Monitoring costs include an initial capital investment and annual costs that consist of monitoring system operation and maintenance costs, monitoring system reporting and recordkeeping costs, and property taxes, insurance, and administrative costs. We estimated monitoring costs for the tube dryer system based on costs for a CPMS for monitoring and recording up to two process or control device parameters. We estimated emissions testing costs based on EPA Method 5.

The EPA did not identify regulatory options more stringent than the MACT floor for new sources.

3.2.4.1.5 Softwood Veneer Dryer (Heated Zones)

Softwood veneer dryers remove excess moisture from veneer by conveying the veneer through a heated medium, generally on rollers, belts, cables, or wire mesh. Softwood veneer dryers dry veneer with greater than or equal to 30 percent softwood species on an annual volume basis. Veneer kilns that operate as batch units, veneer dryers heated by radio frequency or microwaves that are used to redry veneer, and veneer redryers heated by conventional means are not considered to be softwood veneer dryers.

There are three existing softwood veneer dryer systems with direct wood-fired heated zones in the U.S. Two systems are controlled by an RTO and one system is controlled using dry electrostatic precipitators (ESP) and an RTO. The EPA expects existing dryer systems will meet the PM MACT floor using the technology already installed.

The incremental costs associated with the standards based on the PM MACT floor for existing direct wood-fired softwood veneer dryer system heated zones consist of monitoring, emissions testing, and reporting and recordkeeping costs. Monitoring costs for the two systems controlled only by an RTO include an initial capital investment and annual operation and maintenance costs. We estimated monitoring costs for these two systems based on a COMS. We estimated emissions testing costs for these systems based on EPA Method 5. We estimated annual reporting and recordkeeping costs separately from monitoring costs. The annual reporting and recordkeeping costs consist of labor costs for compiling data and entering and verifying information in semiannual reports. We estimated labor costs for reporting and recordkeeping based on a composite of technical, management, and clerical wage rates plus fringe benefits and overhead. We estimated monitoring costs for the one system controlled by a dry ESP and an RTO based on a CPMS for monitoring one air pollution control device parameter. The monitoring costs include an initial capital investment and annual costs consisting of operation and maintenance, reporting and recordkeeping, and property taxes, insurance, and administrative costs. We estimated emissions testing costs for this system based on EPA Method 5.

The EPA did not identify regulatory options more stringent than the PM MACT floor for existing direct wood-fired softwood veneer dryer heated zones, and no new (or reconstructed) sources are projected in the next five years.

3.2.4.2 PCWP Wood-Fired Dryer Mercury

The EPA proposed and is updating and finalizing numeric standards for mercury (Hg) emissions from combustion in existing and new direct wood-fired PCWP dryers. Due to the low levels of Hg emissions from PCWP dryers, which were usually below three times the representative detection level of the measurement method (*i.e.*, 3xRDL, the minimum level at which emissions can reliably be measured for comparison to the MACT floor), the EPA expects all PCWP dryers will meet the Hg MACT floors for existing and new sources with the baseline level of control. For PCWP rotary strand, green rotary, tube, and softwood veneer dryers, the baseline level of control is typically a PM and HAP control device in series (*e.g.*, WESP/RTO or similar). The baseline level of control for dryer rotary dryers is a mechanical collector (*e.g.*, multiclone).

The incremental costs associated with the standards based on the Hg MACT floor for existing and new direct wood-fired PCWP dryers are limited to emissions testing costs based on EPA Method 29 for speciated metals including Hg.

The EPA did not identify regulatory options more stringent than the Hg MACT floors for existing or new PCWP dryers.

3.2.4.3 PCWP Wood-Fired Dryer Acid Gases

The EPA proposed and is finalizing numeric standards for acid gas emissions from combustion in existing and new direct wood-fired PCWP dryers. As part of the 2022 section 114 survey, emissions testing for HCl, HF, and Cl_2 was conducted using EPA Method 26A. Emissions of HF were below detection limit in 99 percent of the EPA Method 26A test runs and emissions of Cl_2 were below detection limit in 65 percent of the test runs. Emissions of HCl were detected in 71 percent of the test runs. Using data from the test runs, the EPA proposed numerical standards for emissions of acid gases based on HCl emissions from combustion in direct wood-fired rotary strand dryers, green rotary dryers, and tube dryers. The EPA did not consider acid gas standards for softwood veneer dryers because acid gas emissions were not detected in emissions measurements. The EPA is now finalizing the proposed standards.

We estimated cost impacts of the acid gas MACT options for existing and new sources for direct wood-fired rotary strand dryers, green rotary dryers, and primary and secondary tube dryers. In cases where the EPA did not expect the HCl emission level options will be met based on the actual or estimated acid gas performance level for each dryer system, we considered the performance level to estimate whether the dryer system will require an upgrade. We developed cost estimates if a control technology upgrade was estimated to be needed. In most cases, if the EPA estimated that an upgrade to the air pollution control would be needed to meet the acid gas MACT option under consideration, that upgrade was already factored into the compliance cost estimates for the PM MACT standards. In these cases, we did not double count costs associated with air pollution control and monitoring for the acid gas MACT option. We also estimated emissions testing and reporting and recordkeeping costs.

3.2.4.3.1 Rotary Strand Dryers

The EPA expects all existing direct wood-fired rotary strand dryer systems will meet the HCl MACT floor with the baseline controls in place, so no incremental control costs are expected. Therefore, the incremental costs for the HCl MACT floor for existing direct wood-fired rotary strand dryer systems consist of emission testing costs based on EPA Method 26A.

The EPA did not identify regulatory options more stringent than the HCl MACT floor for existing direct wood-fired rotary strand dryers.

The EPA projected two new direct wood-fired rotary strand dryer systems within the next five years will require upgraded air pollution control devices to meet the HCl MACT floor. The HCl MACT floor for new direct wood-fired rotary strand dryers is about 10 percent lower than the average HCl emissions from rotary strand dryer systems included in the section 114 tests. Although below the average performance level of dryers tested, the HCl MACT floor emission level has been achieved by 3 rotary strand dryers with WESP control and a rotary strand dryer with a multiclone. Therefore, the EPA expects the new source MACT floor for rotary strand dryers will be met with a well-performing WESP system. A WESP/RTO system is the most likely control system to be installed in the absence of the standards finalized by this rule, so the incremental control costs associated with the standards based on the HCl MACT floor are those for an upgraded system with improved performance. An example of a well-performing WESP is one that incorporates caustic addition (*e.g.*, 1 percent) into the WESP recirculation water and has increased blowdown. We already included these upgrades in the incremental cost for an upgraded WESP associated with the PM MACT floor for new sources, so we did not estimate additional control costs. Therefore, the incremental costs associated with the HCl MACT floor for new direct wood-fired rotary strand dryer systems consist of emission testing costs based on EPA Method 26A.

The EPA did not identify regulatory options more stringent than the HCl MACT floor for new direct wood-fired rotary strand dryers.

3.2.4.3.2 Green Rotary Dryers

The EPA expects existing and new direct wood-fired green rotary dryer systems will meet the HCl MACT floor with baseline controls, so no incremental control costs are expected.

Therefore, the incremental costs associated with the HCl MACT floor for existing and new green rotary dryers consist of emissions testing costs based on EPA Method 26A.

The EPA did not identify regulatory options more stringent than the MACT floor for existing or new green rotary dryers.

3.2.4.3.3 Dry Rotary Dryers

The EPA expects existing direct wood-fired dry rotary dryer systems will meet the HCl MACT floor with baseline controls, so no incremental control costs are expected. Therefore, the incremental costs for the HCl MACT floor for existing dry rotary dryers consist of emissions testing costs based on EPA Method 26A.

The EPA projected no new direct wood-fired dry rotary dryers will be constructed within the next five years.

The EPA did not identify regulatory options more stringent than the MACT floor for existing or new dry rotary dryers.

3.2.4.3.4 Primary and Secondary Tube Dryers

The EPA expects existing and new direct wood-fired primary tube dryer systems will meet the HCl MACT floors with baseline controls which typically incorporate a WESP or scrubber. The EPA expects the one new wood-fired primary tube dryer projected to come online with the WESP or scrubber technology needed to meet the HCl MACT floor for new sources, so incremental costs for new sources consist of only emissions testing based on EPA Method 26A.

Wood-fired secondary tube dryers vent into the primary tube dryers and out the same emission point. Therefore, the primary tube dryer MACT options also apply for secondary tube dryers, and costs based on emissions testing are included in the emissions testing costs for the primary tube dryers. The EPA projected no new secondary tube dryers will be constructed in the next five years.

The EPA did not identify regulatory options more stringent than the existing and new source MACT floors for primary or secondary tube dryers.

3.2.4.4 PCWP Wood-Fired Dryer PAH

The EPA proposed and is updating and finalizing numeric standards for PAH emissions from combustion in new and existing direct wood-fired PCWP dryers. The EPA is finalizing numeric standards for PAH emissions for rotary strand dryers, green rotary dryers, dry rotary dryers, and primary and secondary tube dryers. The EPA is not finalizing the proposed numeric standards for wood-fired softwood veneer dryers, instead requiring PAH testing to be included in the performance tests of these dryers in addition to the burner tune-up standards discussed in Section 3.2.4.6.

We estimated cost impacts of the numeric PAH standards for direct wood-fired rotary strand dryers, green rotary dryers, dry rotary dryers, and primary and secondary tube dryers. In cases where the EPA did not expect PAH emission level options to be met based on the actual or estimated PAH performance level for each dryer system, we considered the performance level to estimate whether the dryer system will require an upgrade to meet the MACT option. We developed cost estimates if we estimated a control technology upgrade will be needed. In addition to control technology costs, we also estimated incremental monitoring, emissions testing, and reporting and recordkeeping costs.

3.2.4.4.1 Rotary Strand Dryers

The EPA expects most existing direct wood-fired rotary strand dryer systems will meet the PAH MACT floor with the baseline PM and HAP controls in series. The EPA estimated one rotary strand dryer system with an ESP but no HAP control device will add an RTO to achieve the PAH MACT floor. We expect this one system will incur incremental control costs for an RTO for two dryers to meet the standards based on the PAH MACT floor as well as associated monitoring costs for a CPMS for monitoring one parameter.

In addition to the control technology and monitoring costs for the one wood-fired rotary strand dryer system without a HAP control device, costs associated with the standards based on the PAH MACT floor for existing wood-fired rotary strand dryers include emissions testing costs. We estimated emissions testing costs based on EPA Method 23.

The EPA did not identify regulatory options more stringent than the PAH MACT floor for existing direct wood-fired rotary strand dryers.

The EPA expects new direct wood-fired rotary strand dryer systems will be challenged to meet the new-source PAH MACT floor despite coming online with a WESP/RTO control system. While the new source MACT floor emission level is achievable (and was achieved by the best-performing rotary strand dryer with a MC/RTO control system and one other rotary strand dryer with a WESP/RTO), the new source PAH MACT floor is 90 percent lower than the average PAH performance level achieved by the well-controlled rotary strand dryers in the Section 114 emission tests. The EPA expects the burner tune-up requirements required for all direct-fired PCWP dryers will help with meeting the PAH MACT floor. We discuss the costs associated with burner tune-ups in Section 3.1.4. In addition, costs for an upgraded WESP system over the baseline were included with the PM MACT floor estimates. We estimated no other incremental control equipment costs in association with the PAH MACT floor given that the EPA expects the baseline emissions control system to remain the same.

We estimated additional incremental emissions testing costs in association with the new-source PAH MACT floor, assuming two stack tests for engineering purposes in addition to the compliance tests. Therefore, we expect a total of three tests will be needed to fine-tune dryer and control system operation for adherence to the new-source PAH limit. We estimated emissions testing costs based on EPA Method 23.

The EPA did not identify regulatory options more stringent than the PAH MACT floor for new sources.

3.2.4.4.2 Green Rotary Dryers

The EPA expects existing direct wood-fired green rotary dryer systems will meet the PAH MACT floor with baseline HAP controls, so no incremental control equipment costs are expected. Additional cost impacts for existing wood-fired green rotary dryers include costs related to emissions testing. We estimated emissions testing costs based on EPA Method 23. The EPA did not identify regulatory options more stringent than the MACT floor were identified for existing sources.

The EPA expects new direct wood-fired green rotary dryer systems will be challenged to meet the new-source PAH MACT floor despite coming online with a WESP/RTO control system. While the new source MACT floor is achievable (and was achieved by the best-performing green rotary dryer with a WESP/RTO control system), the new source PAH MACT is approximately 60 percent lower than the average PAH performance achieved by the well-controlled green rotary dryers in the Section 114 emission tests. The EPA expects the burner tune-up requirements required for all direct-fired PCWP dryers will help with meeting the PAH MACT floor. We discuss the costs associated with burner tune-ups in Section 3.2.4.6. We estimated no other incremental control costs in association with the PAH MACT floor given that the EPA expects the baseline emissions control system to remain the same.

We estimated additional incremental emissions testing costs in association with the new-source PAH MACT floor, assuming two stack tests for engineering purposes in addition to the compliance tests. Therefore, we expected a total of three tests will be needed to fine-tune dryer and control system operation for adherence to the new-source PAH limit. We estimated emissions testing costs based on EPA Method 23.

The EPA did not identify regulatory options more stringent than the MACT floor for new sources.

3.2.4.4.3 Dry Rotary Dryers

The EPA expects existing direct wood-fired dry rotary dryer systems will meet the PAH MACT floor with baseline controls, so no incremental control equipment costs are expected.

Additional cost impacts for existing wood-fired dry rotary dryers include costs related to emissions testing. We estimated emissions testing costs based on EPA Method 23.

An option more stringent than the PAH MACT floor for existing sources would be based on use of a WESP/RTO system. The WESP would protect the RTO from particulate build up (and is a beyond-the-floor option for PM as discussed in section 3.1.3.2.3). The EPA expects the RTO would achieve a reduction in PAH emissions as would be needed to meet the dry rotary dryer new source MACT floor. Because we already estimated the incremental cost of the WESP for the more stringent PM MACT option, we estimated only the incremental cost of the RTO for the more stringent PAH option.

Additional cost impacts for existing wood-fired dry rotary dryers under the more stringent PAH MACT option include monitoring and emissions testing costs. Incremental monitoring costs are based on a CPMS for monitoring of the RTO temperature and consist of an initial capital investment and annual monitoring system operation and maintenance, reporting and recordkeeping, and property taxes, insurance, and administrative costs. We estimated missions testing costs are the same as under the PAH MACT floor scenario and are based on EPA Method 23.

The EPA projected no new direct wood-fired dry rotary dryers over the next five years, and no options more stringent than the new source PAH MACT floor were identified.

3.2.4.4.4 Primary and Secondary Tube Dryers

The EPA expects existing and new wood-fired primary and secondary tube dryer systems will meet the PAH MACT floors. The EPA expects existing sources will meet the PAH MACT floors with baseline controls which typically incorporate a HAP control device, and the EPA expects the one new source projected will come online with the control technology (*e.g.*, scrubber or WESP and RTO) needed to meet the PAH MACT floor for new sources. Therefore, we do not expect incremental control equipment costs.

Additional cost impacts for existing and new wood-fired primary and secondary tube dryers include costs related to emissions testing. We estimated emissions testing costs based on EPA Method 23. Because wood-fired secondary tube dryers vent into the primary tube dryers and out the same emissions point, we only estimated incremental emissions testing costs for the primary tube dryers to avoid double counting.

The EPA did not identify regulatory options more stringent than the PAH MACT floors for existing or new primary and secondary tube dryers.

3.2.4.5 PCWP Wood-Fired Dryer Dioxin/Furan

The EPA proposed work practice standards requiring burner tune-ups to address emissions of dioxin/furans (D/F) from wood-fired PCWP dryers. The EPA proposed the burner tune-up standards to address D/F emissions in place of a numerical MACT floor because D/F was not detected in more than 55 percent of emissions test runs. In response to public comments, the EPA updated its analysis to adhere to guidance for evaluating when to establish numerical MACT limits versus establishing work practices. Upon reanalysis, the percentage of non-detect runs remained the same as proposed for wood-fired rotary strand dryers, dry rotary dryers, and tube dryers. However, based on the reanalysis, the EPA is finalizing numerical standards for D/F emissions from wood-fired green rotary dryers.

3.2.4.5.1 Green Rotary Dryers

The EPA added an emission limit for D/F emissions from existing and new wood-fired green rotary dryers for the final rule following reevaluation of emissions data conducted as a result of public comments. The EPA expects existing and new units will meet their respective D/F MACT floors with the baseline HAP controls. The cost associated with emissions testing is included in the cost for PAH testing which is conducted using the same test method as D/F, and no monitoring or reporting or recordkeeping costs are required beyond those for meeting the

PAH standards. The EPA did not identify regulatory options more stringent than the MACT floor for existing or new sources.

3.2.4.6 Direct-Fired Dryer Burner Tune-Up and Bypass Stack Monitoring

The EPA proposed and is updating and finalizing burner tune-up standards to address emissions of D/F from wood and other fuel fired PCWP dryers, any combustion-related HAP that may be emitted from natural-gas fired PCWP dryers, and any HAP from combustion unit bypass stacks. As mentioned in Section 3.2.1, the EPA is also finalizing burner tune-ups as a standard for direct-fired lumber kilns to address combustion-related HAP emissions from direct fuel firing and kiln combustion unit bypass stacks. In addition, the EPA is finalizing standards requiring monitoring and recording of bypass stack usage.

We estimated the costs of burner tune-ups based on estimates developed for the Boiler MACT. The Boiler MACT requires annual tune ups for new or existing boilers or process heaters without a continuous oxygen trim system and with heat input capacity of 10 MMBtu/hr or greater as a work practice for emissions of D/F (40 CFR 63.7540). Based on information available to EPA from the PCWP ICR, most direct-fired PCWP dryer burners have 10 MMBtu/hr or greater heat input capacity. Therefore, for the PCWP cost analysis, no distinction in burner size or tune-up frequency was made, and we estimated tune-up costs based on the annual tune-up cost estimate developed for the Boiler MACT.

The Boiler MACT annual tune-up cost estimate was based on the estimated cost to conduct an annual tune-up on an industrial, commercial, or institutional boiler. Annual tune-up costs were estimated based on a report by Dr. H.M. Eckerlin and E.W. Soderberg of the Industrial Extension Service USI Boiler Efficiency Program that found the initial set-up for a boiler tune-up ranges from $3,000 to $7,000 per boiler (in 2004 dollars), and thereafter, an annual tune-up costs $1,000 per boiler per year.[14, 15] For the present analysis, we assumed the initial tuning costs equaled an average of $5,000, or $7,923 when updated to 2024 dollars. We annualized this cost over a period of five years and added it to the subsequent year costs for an annual tune-up, which equals $1,585 when adjusted to 2024 dollars. We applied the cost of annual burner tune-ups for direct wood-fired dryers, direct natural gas-fired dryers, and lumber kilns in the PCWP source category.

The combustion unit bypass stack monitoring standard requires monitoring and reporting bypass stack usage. Usage time will be monitored using an indicator such as bypass damper position or temperature in the bypass stack. Cost impacts for combustion unit bypass stack monitoring include an initial capital investment and annual costs that consist of monitoring system operation and maintenance costs, monitoring system reporting and recordkeeping costs, and property taxes, insurance, and administrative costs. We estimated monitoring costs based on costs for a CPMS for one air pollution control device parameter.

3.2.5 Emissions Testing, Monitoring, and Reporting and Recordkeeping Costs

Table 3-1 presents estimated emissions testing costs for different test methods. We treated emissions testing costs as capital costs because facilities contract with testing companies to perform the testing for initial and five-year repeat tests. We annualized the capital costs over a five-year testing interval. The testing costs in Table 3-1 include costs associated with

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[14] Eckerlin, H., & Soderberg, E. (2004). A Report Summarizing the Findings and Recommendatons of an Evaluation of Boilers in State Operated Facilities. Retrieved from docket: https://www.regulations.gov/document/EPA-HQ-OAR-2016-0243-0329.

[15] ERG. (2011). (Revised November 2011) Methodology for Estimating Control Costs for Industrial, Commercial, Institutional Boilers and Process Heaters National Emission Standards for Hazardous Air Pollutants - Major Source. Retrieved from docket: https://www.regulations.gov/document/EPA-HQ-OAR-2016-0243-0336.

mobilization for three test runs, test report preparation, and entering information into the EPA's Electronic Reporting Tool for currently supported test methods (*i.e.*, all methods listed except NCASI A105.1).

Table 3-1 Emission Testing Costs ($2024)

Test Method	Capital Cost Per Test Every 5 Years	Annualized Capital Cost Per Test, $/yr[a]
EPA Method 320 or NCASI A105.1 (HAP)	$15,000 (outlet) $30,000 (inlet/outlet)	$3,683 (outlet) $7,366 (inlet/outlet)
EPA Method 326 (MDI)	$14,000	$3,437
EPA Method 5 (PM as surrogate for non-Hg HAP metals)	$10,000	$2,455
EPA Method 29 (speciated metals including Hg)	$18,000	$4,419
EPA Method 26A (acid gases)	$12,000	$2,946
EPA Method 23 (PAH, D/F)	$20,000	$4,911

[a] Annualized over the five-year testing period at 7.25% interest.

Table 3-2 presents estimated monitoring costs. We present costs for a CPMS for one and two air pollution control device parameters and for a COMS.

Table 3-2 Monitoring Costs ($2024)

Cost Factor	CPMS for One Parameter	CPMS for Two Parameters	COMS
Total Capital Investment	$23,109	$46,309	$175,805
Annualized Capital	$2,224[a]	$4,457[a]	$25,321[b]
Annual Costs	$8,060	$11,308	$31,820
Total Annualized Costs	$10,284	$15,765	$57,141

[a] Annualized using a capital recovery factor of 7.25% and assuming a 20-year equipment life. [b] Annualized using a capital recovery factor of 7.25% and assuming a 10-year equipment life.

We estimated CPMS costs considering the costs of planning, selecting, purchasing, installing, and operating and maintaining a data acquisition system (DAS). The DAS and associated software may be connected to sensors and logic controllers that track multiple parameters. We assigned the one-parameter costs for temperature monitoring only, bypass stack monitoring (*e.g.*, for one indicator of bypass stack use such as temperature or damper position monitoring), and dry ESPs which will be required to monitor total secondary power output. We assigned the two-parameter CPMS costs for WESPs (liquid flow and total secondary power), scrubbers (liquid flow and pressure-drop or pH), and electrified filter beds (EFBs) (pressure drop and voltage).

For dry control devices other than the controls noted above, we estimated COMS costs based on the EPA Air Pollution Control Cost Manual, Section 2, Chapter 4.[16] We assigned the COMS costs for each PCWP dryer with a mechanical collector, baghouse, or other dry PM control device.

Reporting and recordkeeping costs are included in the estimate of CPMS annual costs in Table 3-2. For systems not monitored by a CPMS, we estimated reporting and recordkeeping costs based on the number of hours per year for reporting and recordkeeping to demonstrate continuous compliance with the standards. We multiplied the estimated labor hours by the reporting and recordkeeping composite wage rate. We assigned the reporting and recordkeeping costs in Table 3-3 for each process requiring a COMS or other method of demonstrating ongoing compliance that does not involve use of a CPMS.

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[16] U.S. EPA. (2000b). Air Pollution Control Cost Manual (EPA/452/B-02-001). Retrieved from docket: https://www.regulations.gov/document/EPA-HQ-OAR-2016-0243-0325.

Table 3-3 Reporting and Recordkeeping of Information Not Involving CPMS

Activity	Labor hours per year	Annual cost, \$/yr[a]
Compile data	48	\$7,986
Enter and verify information for semiannual reports	32	\$5,324
Total	80	\$13,310

[a] Calculated using an hourly wage rate of \$166.37/hr in 2024 dollars based on a composite of technical, management, and clerical reporting and recordkeeping wages that are inclusive of fringe benefits and overhead.

3.2.6 Cost Summary

Table 3-4, below, presents a summary of the compliance costs for the final PCWP amendments by emission point and in total. The total capital cost (synonymous with total capital investment, or TCI) of the final PCWP amendments is about \$121 million, and the total annual cost is about \$40.7 million in 2024 dollars. Estimates of total annual cost include annual costs such as operating and maintenance and reporting and recordkeeping costs. Estimates of total annual cost do not include annualized capital costs.

Table 3-4 Nationwide Costs by Emission Point for the Final Rule ($2024)

Emission Point	Existing & New Source Total Capital Cost ($)	Existing & New Source Total Annual Cost ($/yr)
Organic HAP Standards		
Lumber Kiln WP (with burner tune up)	$ 21,628,441	$ 20,695,186
Log Vat WP	$ 1,345,299	$ 416,241
HB Digester/Washer WP[a]	$ 0	$ 0
HB Mat Dryer/Predryer MACT Floor[a]	$ 0	$ 0
Atmospheric Refiner MACT Floor	$ 5,480,900	$ 1,723,714
RMH Process Units (All) WP	$ 1,996,382	$ 2,040,573
MDI Standards		
Misc. Coating MDI	$ 14,000	$ 7,730
Tube Dryer MDI	$ 84,000	$ 0
Recon. Wood Products Presses MDI	$ 2,892,114	$ 1,024,617
Combustion HAP Standards		
RSD PM/Metal MACT Floor	$ 68,901,128	$ 9,974,057
GRD PM/Metal MACT Floor	$ 370,964	$ 75,909
DRD PM/Metal MACT Floor	$ 557,415	$ 135,390
TD PM/Metal MACT Floor	$ 911,502	$ 200,093
SVD PM/Metal MACT Floor	$ 404,719	$ 98,320
PCWP Dryer Hg MACT Floor	$ 936,000	$ 0
RSD HCl MACT Floor	$ 324,000	$ 0
GRD HCl MACT Floor	$ 84,000	$ 0
DRD HCl MACT Floor	$ 36,000	$ 0
TD HCl MACT Floor	$ 144,000	$ 0
RSD PAH MACT Floor	$ 3,894,860	$ 946,261
GRD PAH & D/F MACT Floors	$ 180,000	$ 0
DRD PAH MACT Floor	$ 60,000	$ 0
TD PAH MACT Floor	$ 240,000	$ 0
Direct-fired Dryer Burner Tune-Up	$ 1,097,913	$ 207,635
Bypass Stacks	$ 9,105,030	$ 3,175,693
Total	$ 120,688,668	$ 40,721,421
Total (rounded to 3 significant figures)	$ 121,000,000	$ 40,700,000

a. The one facility operating a HB Digester/Washer and a HB Mat Dryer and Predryer closed between the proposal and final rule, so the final MACT standards have an associated cost of $0 for these process units.

Total costs are greater under the more stringent regulatory option, presented in Table 3-5. The more stringent regulatory option includes stricter standards for fiberboard mat dryer heated zones and hardboard press predryers, atmospheric refiners, and emissions of PM/HAP metals and PAH from direct wood-fired dry rotary dryers. Because the one facility operating a fiberboard mat dryer and hardboard press predryer closed and is not expected to reopen, total capital and annual costs under the more stringent standards equal $0 for these process units.

Estimates of costs for the more stringent standards for atmospheric refiners and the more stringent PM/HAP metal and PAH standards for direct wood-fired dry rotary dryers, however, are greater than those under the final regulatory option. Therefore, total capital costs under the more stringent regulatory option are approximately $215 million and total annual costs equal about $63.6 million.

Table 3-5 Nationwide Costs by Emission Point for the More Stringent Regulatory Option ($2024)

Emission Point	Existing & New Source Total Capital Cost ($)	Existing & New Source Total Annual Cost ($/yr)
Organic HAP Standards		
Lumber Kiln WP (with burner tune up)	$ 21,628,441	$ 20,695,186
Log Vat WP	$ 1,345,299	$ 416,241
HB Digester/Washer WP[a]	$ 0	$ 0
HB Mat Dryer and Predryer Option (RTO)[a]	$ 0	$ 0
Atmospheric Refiner Option (Table 1B RTO)	$ 79,987,321	$ 21,009,048
RMH Process Units (All) WP	$ 1,996,382	$ 2,040,573
MDI Standards		
Misc. Coating MDI	$ 14,000	$ 7,730
Tube Dryer MDI	$ 84,000	$ 0
Recon. Wood Products Presses MDI	$ 2,892,114	$ 1,024,617
Combustion HAP Standards		
RSD PM/Metal MACT Floor	$ 68,901,128	$ 9,974,057
GRD PM/Metal MACT Floor	$ 370,964	$ 75,909
DRD PM/Metal Option (WESP)	$ 14,314,648	$ 2,063,750
TD PM/Metal MACT Floor	$ 911,502	$ 200,093
SVD PM/Metal MACT Floor	$ 404,719	$ 98,320
PCWP Dryer Hg MACT Floor	$ 936,000	$ 0
RSD HCl MACT Floor	$ 324,000	$ 0
GRD HCl MACT Floor	$ 84,000	$ 0
DRD HCl MACT Floor	$ 36,000	$ 0
TD HCl MACT Floor	$ 144,000	$ 0
RSD PAH MACT Floor	$ 3,894,860	$ 946,261
GRD PAH & D/F MACT Floors	$ 180,000	$ 0
DRD PAH Option (RTO)	$ 6,049,042	$ 1,703,943
TD PAH MACT Floor	$ 240,000	$ 0
Direct-fired Dryer Burner Tune-Up	$ 1,097,913	$ 207,635
Bypass Stacks	$ 9,105,030	$ 3,175,693
Total	$ 214,941,364	$ 63,639,058
Total (rounded to 3 significant figures)	$ 215,000,000	$ 63,600,000

a. The one facility operating a HB Digester/Washer and a HB Mat Dryer and Predryer closed between the proposal and final rule, so the more stringent standards have an associated cost of $0 for these process units.

Table 3-6 presents undiscounted and discounted cost estimates for the final rule over the 2026-2045 analytical timeframe. Estimates include both capital costs and annual costs and are presented starting in the year in which the final rule will be fully implemented (2026), extending over the lifetime of the control equipment that may be installed in response to the rule, and ending in 2045. We provide a description of the costs incurred each year. Table 3-6 also presents the present value (PV) and equivalent annualized value (EAV) for the discounted costs. The PV is an estimate of the value in 2026 of all costs incurred both in 2026 and in the future. We calculate the PV by summing all discounted costs. The EAV is an estimate of the value in 2026 of the average cost incurred each year in the analytical timeframe. The PV of the compliance costs over the 20-year analytical timeframe is $639 million at a 3 percent discount rate and $471 million at a 7 percent discount rate. The EAV of the compliance costs is $46 million at a 3 percent discount rate and $47 million at a 7 percent discount rate.

Table 3-7 presents the same information as Table 3-6 but for costs associated with the more stringent regulatory option. Under the more stringent regulatory option, the timing of the costs remains the same as under the final rule but estimates of the total capital cost and total annual cost increase. Therefore, the PV of the compliance costs over the 20-year analytical timeframe for the more stringent option is $1,013 million at a 3 percent discount rate and $752 million at a 7 percent discount rate. The EAV of the compliance costs is $74 million at a 3 percent discount rate and $75 million at a 7 percent discount rate.

Table 3-6 Discounted Costs by Year for the Final Rule (million $2024, discounted to 2026)

Year	Cost Description	Undiscounted Total Costs (0% D.R.)	Discounted Total Costs (3% D.R.)	Discounted Total Costs (7% D.R.)
2026	Rule becomes effective. Assume all new sources startup; includes new source capital costs.	$ 17.67	$ 17.67	$ 17.67
2027	New sources start incurring annual costs. Includes ½ of the capital costs for existing sources.	$ 54.09	$ 52.51	$ 50.55
2028	Existing sources must comply by year 3. Includes ½ of the capital costs for existing sources.	$ 54.09	$ 50.98	$ 47.24
2029	Existing sources incur initial testing costs and start incurring annual costs.	$ 44.56	$ 40.78	$ 36.38
2030		$ 40.72	$ 36.18	$ 31.07
2031	5-year repeat testing (new sources)	$ 41.15	$ 35.50	$ 29.34
2032		$ 40.72	$ 34.10	$ 27.13
2033		$ 40.72	$ 33.11	$ 25.36
2034	5-year repeat testing (existing sources)	$ 44.56	$ 35.18	$ 25.94
2035		$ 40.72	$ 31.21	$ 22.15
2036	5-year repeat testing (new sources)	$ 41.15	$ 30.62	$ 20.92
2037		$ 40.72	$ 29.42	$ 19.35
2038		$ 40.72	$ 28.56	$ 18.08
2039	5-year repeat testing (existing sources)	$ 44.56	$ 30.34	$ 18.49
2040		$ 40.72	$ 26.92	$ 15.79
2041	5-year repeat testing (new sources)	$ 41.15	$ 26.41	$ 14.92
2042		$ 40.72	$ 25.38	$ 13.79
2043		$ 40.72	$ 24.64	$ 12.89
2044	5-year repeat testing (existing sources)	$ 44.56	$ 26.18	$ 13.18
2045		$ 40.72	$ 23.22	$ 11.26
PV[a]			$ 639	$ 471
EAV[a]			$ 46	$ 47

Table 3-7 Discounted Costs by Year for the More Stringent Option (million $2024, discounted to 2026)

Year	Cost Description	Undiscounted Total Costs (0% D.R.)	Discounted Total Costs (3% D.R.)	Discounted Total Costs (7% D.R.)
2026	Rule becomes effective. Assume all new sources startup; includes new source capital costs.	$ 17.67	$ 17.67	$ 17.67
2027	New sources start incurring annual costs. Includes ½ of the capital costs for existing sources.	$ 101.24	$ 98.29	$ 94.62
2028	Existing sources must comply by year 3. Includes ½ of the capital costs for existing sources.	$ 101.24	$ 95.43	$ 88.43
2029	Existing sources incur initial testing costs and start incurring annual costs.	$ 67.42	$ 61.70	$ 55.03
2030		$ 63.64	$ 56.54	$ 48.55
2031	5-year repeat testing (new sources)	$ 64.07	$ 55.27	$ 45.68
2032		$ 63.64	$ 53.30	$ 42.41
2033		$ 63.64	$ 51.74	$ 39.63
2034	5-year repeat testing (existing sources)	$ 67.42	$ 53.22	$ 39.24
2035		$ 63.64	$ 48.77	$ 34.62
2036	5-year repeat testing (new sources)	$ 64.07	$ 47.67	$ 32.57
2037		$ 63.64	$ 45.97	$ 30.23
2038		$ 63.64	$ 44.64	$ 28.26
2039	5-year repeat testing (existing sources)	$ 67.42	$ 45.91	$ 27.98
2040		$ 63.64	$ 42.07	$ 24.68
2041	5-year repeat testing (new sources)	$ 64.07	$ 41.12	$ 23.22
2042		$ 63.64	$ 39.66	$ 21.56
2043		$ 63.64	$ 38.50	$ 20.15
2044	5-year repeat testing (existing sources)	$ 67.42	$ 39.60	$ 19.95
2045		$ 63.64	$ 36.29	$ 17.60
PV			$ 1,013	$ 752
EAV			$ 74	$ 75

3.3 EMISSIONS IMPACTS

Implementing the final amendments is expected to reduce emissions of HAP and non-HAP pollutants, such as VOC. Table 3-8 provides a summary of the expected annual emissions impacts for the final rule, including both primary emissions impacts targeted by the rule and secondary impacts expected to result from compliance actions, such as those resulting from changes in energy and electricity consumption due to the operation of control devices and monitoring equipment. The final rule is expected to reduce emissions of HAP by 721 tons per year (tpy), VOC (a precursor to ozone) by 8,504 tpy, NO_x (a precursor to ozone and $PM_{2.5}$) by 120 tpy, SO2 (a precursor to $PM_{2.5}$) by 0.57 tpy, directly emitted $PM_{2.5}$ by 142 tpy, and CO by 701 tpy.

Table 3-8 Summary of Emissions Reductions (Increases) for the Final Rule

Pollutant	Primary (tpy)	Secondary (tpy)	Total (tpy)
HAP	721		721
Organic HAP	717		717
Non-Hg HAP Metals	2.66		2.66
Hg	0.01	(0.0003)	0.01
Acid Gas	0.77		0.77
MDI	0.08		0.08
PAH	0.22		0.22
VOC	8,504		8,504
PM	202	(4.53)	197
$PM_{2.5}$	144	(1.72)	142
NO_x	132	(11.9)	120
CO	719	(18.4)	701
SO_2	12.5	(11.9)	0.57
CO_2	126,749	(19,507)	107,242
CH_4	10.9	(1.55)	9.33
N_2O	4.53	(0.21)	4.31
CO_2e	127,428	(19,610)	107,818

Summer season VOC and NO_x emissions undergo chemical reactions in the presence of sunlight resulting in ground-level ozone formation; therefore, this rulemaking is assumed to reduce ozone concentrations. However, air quality modeling was not conducted for this rule, and in the absence of air quality modeling, there is uncertainty in how ozone concentrations will change in response to changes in emissions.

The more stringent regulatory option establishes stricter standards and makes different assumptions about control devices and monitoring that affect expected emissions impacts. Table 3-9 summarizes the expected annual emissions impacts for the more stringent option, including both primary emissions impacts targeted by the rule and secondary impacts expected to result from compliance actions. The more stringent option would reduce emissions of HAP by 783 tpy, VOC by 9,391 tpy, and directly emitted $PM_{2.5}$ by 155 tpy, and increase emissions of NO_x by 122 tpy, SO2 by 22.3 tpy, and CO by 37.2 tpy.

Table 3-9 Summary of Emissions Reductions (Increases) for the More Stringent Option

Pollutant	Primary (tpy)	Secondary (tpy)	Total (tpy)
HAP	783		783
Organic HAP	779		779
Non-Hg HAP Metals	2.75		2.75
Hg	0.01	(0.0007)	0.01
Acid Gas	0.77		0.77
MDI	0.08		0.08
PAH	0.23		0.23
VOC	9,391		9,391
PM	252	(13.2)	239
$PM_{2.5}$	160	(5.01)	155
NO_x	(87.3)	(34.8)	(122)
CO	16.4	(53.6)	(37.2)
SO_2	12.5	(34.8)	(22.3)
CO_2	38,855	(56,932)	(18,077)
CH_4	9.23	(4.5)	4.70
N_2O	4.36	(0.63)	3.73
CO_2e	38,782	(57,232)	(18,449)

4 BENEFITS ANALYSIS

The PCWP source category is a source of HAP, CO, VOC, NO_x, SO_2, Ozone, $PM_{2.5}$, and other pollutants. The health effects of exposure to these pollutants are briefly discussed in this section.

4.1 HAZARDOUS AIR POLLUTANTS

This rulemaking is expected to decrease emissions of HAP. The main HAP affected by this rule include organic HAP – acetaldehyde, acrolein, formaldehyde, methanol, phenol, and propionaldehyde – as well as MDI, non-mercury HAP metals, mercury, hydrogen chloride, PAH, and dioxin/furan. Due to methodology and data limitations, we did not attempt to quantify and monetize the health effects associated with HAP emitted from sources subject to this rule. Quantifying and monetizing the economic value of reducing the risk of cancer effects due to HAP exposure is made difficult by the frequent lack of a central estimate of cancer risk as well as estimates of the value of an avoided case of cancer, fatal and non-fatal.[17] Assessing population incidence of non-fatal health effects and risk from threshold carcinogens also poses unique challenges.[18] Therefore, we provide a qualitative discussion of health effects associated with exposure to HAP affected by this rule. Specifically, we discuss the health effects associated with exposure to organic HAP, which account for most of the HAP emissions reductions expected to result from the rule. For information about health effects associated with exposure to the other HAP addressed by the rule, including MDI, non-Hg HAP metals (specifically those found during emissions testing: antimony, arsenic, beryllium, cadmium, chromium, cobalt, lead, manganese,

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[17] LaPenta, M., et al. (2024). Estimated Values of Avoiding Cancer Risks by Cancer Site and Population. *Journal of Benefit-Cost Analysis*, 15(3), 395-439. https://doi.org/10.1017/bca.2024.43.

[18] National Research Council. (2009). Science and Decisions: Advancing Risk Assessment. The National Academies Press. https://doi.org/10.17226/12209.

nickel, and selenium), mercury, hydrogen chloride, PAHs, and dioxin/furan, please refer to the EPA's Health Effects Notebook for Hazardous Air Pollutants and the Integrated Risk Information System (IRIS) database.[19, 20]

4.1.1 Acetaldehyde

Acetaldehyde is ubiquitous in the ambient environment. Acute (short-term) exposure to acetaldehyde results in effects including irritation of the eyes, skin, and respiratory tract. At higher exposure levels, erythema, coughing, pulmonary edema, and necrosis may also occur. Acute inhalation of acetaldehyde has also resulted in a depressed respiratory rate and elevated blood pressure in experimental animals. Symptoms of chronic (long-term) intoxication of acetaldehyde resemble those of alcoholism. In hamsters, chronic inhalation exposure to acetaldehyde has produced changes in the nasal mucosa and trachea, growth retardation, slight anemia, and increased kidney weight. No information is available on the reproductive or developmental effects of acetaldehyde in humans. Acetaldehyde has been shown, in animals, to cross the placenta to the fetus. Data from animal studies suggest that acetaldehyde may be a potential developmental toxin. In one study, a high incidence of embryonic resorptions was observed in mice injected with acetaldehyde. In rats exposed to acetaldehyde by injection, skeletal malformations, reduced birth weight, and increased postnatal mortality have been reported.[21] The EPA has classified acetaldehyde as a probable human carcinogen (Group B2).[22]

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[19] U.S. EPA. Health Effects Notebook for Hazardous Air Pollutants. https://www.epa.gov/haps/health-effects-notebook-hazardous-air-pollutants.

[20] U.S. EPA. Integrated Risk Information System (IRIS). https://www.epa.gov/iris.

[21] U.S. EPA. (2000a). Acetaldehyde [Fact Sheet; CASRN 75-07-0]. https://www.epa.gov/sites/default/files/2016-09/documents/acetaldehyde.pdf.

[22] U.S. EPA. (1988). Acetaldehyde; CASRN 75-07-0 [Integrated Risk Information System (IRIS) Chemical Assessment Summary, Carcinogenicity Assessment]. https://iris.epa.gov/static/pdfs/0290_summary.pdf.

An increased incidence of nasal tumors in rats and laryngeal tumors in hamsters has been observed following inhalation exposure to acetaldehyde.[23]

4.1.2 Acrolein

Acrolein may be formed from the breakdown of certain pollutants found in outdoor air, from the burning of organic matter, or from the burning of fuels. It is toxic to humans following inhalation, oral or dermal exposures. Acute exposure may result in slight eye irritation, nose and throat irritation, and a decrease in respiratory rate. The major effects from chronic inhalation exposure to acrolein in humans and animals consist of general respiratory congestion and eye, nose, and throat irritation. Acrolein is a strong dermal irritant with the eye being the most sensitive target for exposure, and animal studies have reported that the respiratory system is the major target organ for acrolein toxicity. No information is available on the reproductive effects of acrolein in humans. In available reproductive animal studies, rats exposed by inhalation showed no effects on the number of pregnancies, the number and weights of the fetuses, or the overall reproductive fitness of the animals.[24] The EPA IRIS program noted, in 2003, that the potential carcinogenicity of acrolein cannot be determined because the existing data are inadequate for an assessment of human carcinogenic potential for either the oral or inhalation route of exposure.[25]

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[23] U.S. EPA. (2000a). Acetaldehyde [Fact Sheet; CASRN 75-07-0]. https://www.epa.gov/sites/default/files/2016-09/documents/acetaldehyde.pdf.

[24] U.S. EPA. (2009). Acrolein [Fact Sheet; CASRN 107-02-8]. https://www.epa.gov/sites/default/files/2016-08/documents/acrolein.pdf.

[25] U.S. EPA. (2003). Acrolein; CASRN 107-02-8 [Integrated Risk Information System (IRIS) Chemical Assessment Summary, Carcinogenicity Assessment]. https://iris.epa.gov/static/pdfs/0364_summary.pdf.

4.1.3 Formaldehyde

Formaldehyde is used mainly to produce urea-formaldehyde resins and as an intermediate in the synthesis of other chemicals. The major toxic effects caused by acute formaldehyde exposure via inhalation are eye, nose, and throat irritation and effects on the nasal cavity. Other effects seen from exposure to high levels of formaldehyde in humans are coughing, wheezing, chest pains, and bronchitis. Ingestion exposure to formaldehyde in humans has resulted in corrosion of the gastrointestinal tract and inflammation and ulceration of the mouth, esophagus, and stomach. Acute animal tests in rats and rabbits have shown formaldehyde to have high acute toxicity from inhalation, oral, and dermal exposure. Chronic exposure to formaldehyde by inhalation in humans has been associated with respiratory symptoms and eye, nose, and throat irritation. Repeated contact with liquid solutions of formaldehyde has resulted in skin irritation and allergic contact dermatitis in humans. Animal studies have reported effects on the nasal respiratory epithelium and lesions in the respiratory system from chronic inhalation exposure to formaldehyde. An increased incidence of menstrual disorders was observed in female workers using urea-formaldehyde resins; however, confounding factors were not evaluated. Developmental effects, such as birth defects, have not been observed in animal studies with formaldehyde.[26] The EPA has classified formaldehyde as carcinogenic to humans by the inhalation route of exposure.[27] Animal studies have also reported an increased incidence of nasal squamous cell carcinomas by inhalation exposure.[28]

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[26] U.S. EPA. (2000d). Formaldehyde [Fact Sheet; CASRN 50-00-0]. https://www.epa.gov/sites/default/files/2016-09/documents/formaldehyde.pdf.

[27] U.S. EPA. (2024c). IRIS Toxicological Review of Formaldehyde (Inhalation); CASRN 50-00-0 (EPA/635/R-24/162cF). https://iris.epa.gov/static/pdfs/0419_summary.pdf.

[28] U.S. EPA. (2000d). Formaldehyde [Fact Sheet; CASRN 50-00-0]. https://www.epa.gov/sites/default/files/2016-09/documents/formaldehyde.pdf.

4.1.4 Methanol

Methanol is primarily used as an industrial solvent for inks, resins, adhesives, and dyes. It is also used as a solvent in the manufacture of cholesterol, streptomycin, vitamins, hormones, and other pharmaceuticals. Natural emission sources of methanol include volcanic gases, vegetation, microbes, and insects; methanol is also formed during biological decomposition of biological wastes, sewage, and sludge. Acute exposure of humans to methanol by inhalation or ingestion may result in visual disturbances, such as blurred or dimness of vision, leading to blindness. Neurological damage, specifically permanent motor dysfunction, may also result. Contact of skin with methanol can also produce mild dermatitis in humans. Tests involving acute exposure of rats, mice, and rabbits have demonstrated methanol to have low acute toxicity from oral or inhalation exposure, and moderate acute toxicity from dermal exposure. Chronic inhalation or oral exposure may result in headache, dizziness, giddiness, insomnia, nausea, gastric disturbances, conjunctivitis, visual disturbances (blurred vision), and blindness in humans. Elevated levels of liver enzymes and decreased brain weight were observed in rats chronically exposed to methanol via gavage. No information is available on the reproductive or developmental effects of methanol in humans. Developmental effects have been observed in the offspring of rats and mice exposed by inhalation. These included skeletal, cardiovascular, urinary system, and central nervous system malformations in rats and increased resorptions and skeletal and central nervous system malformations in mice.[29] The EPA has not classified methanol with respect to carcinogenicity.

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[29] U.S. EPA. (2000e). Methanol [Fact Sheet; CASRN 67-56-1]. https://www.epa.gov/sites/default/files/2016-09/documents/methanol.pdf.

4.1.5 Phenol

The primary use of phenol is the production of phenolic resins. Phenol is also used in the production of caprolactam and bisphenol A, which are intermediates in the manufacture of nylon and epoxy resins, respectively. Acute inhalation or dermal exposure is highly irritating to the skin, eyes, and mucous membranes in humans. Symptoms of acute toxicity in humans include irregular breathing, muscle weakness and tremors, loss of coordination, convulsions, coma, and respiratory arrest at lethal doses. Acute animal tests in rats, mice, and rabbits have shown phenol to have high acute toxicity from oral exposure. Anorexia, progressive weight loss, diarrhea, vertigo, salivation, a dark coloration of the urine, and blood and liver effects have been reported in chronically exposed humans. Application of phenol to the skin results in dermal inflammation and necrosis. Cardiac arrhythmia has also been reported in humans exposed to high concentrations of phenol. Chronic inhalation exposure of animals to phenol has shown central nervous system, kidney, liver, respiratory, and cardiovascular effects. No information was available concerning the developmental or reproductive effects of phenol in humans. Animal studies have reported reduced fetal body weights, growth retardation, and abnormal development in the offspring of animals exposed by the oral route. Decreased maternal weight gain and increased maternal mortality were also observed.[30] The EPA has classified phenol as a Group D, not classifiable as to human carcinogenicity.[31] Animal studies have not seen tumors resulting from oral exposure, while dermal studies have reported that phenol applied to the skin may be a tumor promotor and/or a weak skin carcinogen in mice.[32]

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[30] U.S. EPA. (2000f). Phenol [Fact Sheet; CASRN 108-95-2]. https://www.epa.gov/sites/default/files/2016-09/documents/phenol.pdf.

[31] U.S. EPA. (2002b). Phenol; CASRN 108-95-2 [Integrated Risk Information System (IRIS) Chemical Assessment Summary, Carcinogenicity Assessment]. https://iris.epa.gov/static/pdfs/0088_summary.pdf.

[32] U.S. EPA. (2000f). Phenol [Fact Sheet; CASRN 108-95-2]. https://www.epa.gov/sites/default/files/2016-09/documents/phenol.pdf.

4.1.6 Propionaldehyde

Limited information is available on the health effects of propionaldehyde. No information is available on the acute, chronic, reproductive, or developmental effects of propionaldehyde in humans. Animal studies have reported that acute exposure to high levels of propionaldehyde, via inhalation, results in anesthesia and liver damage, and intraperitoneal exposure results in increased blood pressure.[33] The EPA has determined there is inadequate information to assess the human carcinogenic potential for propionaldehyde.[34] No information is available on the carcinogenic effects of propionaldehyde in animals.[35]

4.2 CRITERIA POLLUTANTS

Historically, the EPA estimated the monetized benefits of avoided $PM_{2.5}$- and ozone-related impacts, which accounted for most, if not all, of the monetized benefits of many air regulations–even when the regulation was not regulating $PM_{2.5}$ or ozone – within Regulatory Impact Analyses. The Office of Management and Budget (OMB), in its annual report of the Benefits and Costs of Federal Regulations, routinely provides estimates that the monetized benefits from reducing $PM_{2.5}$ and/or ozone exceed hundreds of millions or even billions of dollars and result in most of the monetized benefits from federal regulations.

In previous Regulatory Impact Analyses (RIAs), and memos, the Agency's approach to estimating the impacts to human health of the changes in concentrations of ozone and $PM_{2.5}$ relied substantially on information from the Integrated Science Assessments for ozone and

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[33] U.S. EPA. (2000g). Propionaldehyde [Fact Sheet; CASRN 123-38-6]. https://www.epa.gov/sites/default/files/2016-09/documents/propionaldehyde.pdf.

[34] U.S. EPA. (2008). Propionaldehyde; CASRN 123-38-6 [Integrated Risk Information System (IRIS) Chemical Assessment Summary, Carcinogenicity Assessment]. https://iris.epa.gov/static/pdfs/1011_summary.pdf.

[35] U.S. EPA. (2000g). Propionaldehyde [Fact Sheet; CASRN 123-38-6]. https://www.epa.gov/sites/default/files/2016-09/documents/propionaldehyde.pdf.

particulate matter.[36, 37] These documents synthesize the toxicological, clinical, and epidemiological evidence to determine whether PM and ozone are 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. The ISAs reflect the Agency most up-to-date evaluation of the strength and limitations of the available scientific evidence, and clearly identify the health and welfare endpoints for which the evidence is strongest. The Agency continues to focus on these endpoints in considering how regulatory actions may impact public health and welfare. Historically, the Agency has estimated the incidence of air pollution effects for those health endpoints that the ISA classified as either causal or likely-to-be-causal and these endpoints are shown in Table 4-1. The table below omits welfare effects such as acidification and nutrient enrichment.

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[36] U.S. EPA. (2019b). Integrated Science Assessment for Particulate Matter (EPA/600/R-19/188). Retrieved from: https://www.epa.gov/isa/integrated-science-assessment-isa-particulate-matter.

[37] U.S. EPA. (2020). Integrated Science Assessment for Ozone and Related Photochemical Oxidants (EPA/600/R-20/012). https://www.epa.gov/isa/integrated-science-assessment-isa-ozone-and-related-photochemical-oxidants.

Table 4-1 Health Effects of Ambient Ozone and $PM_{2.5}$

Category	Effect	Causal/Likely-to-be-causal	More Information
Premature mortality from exposure to $PM_{2.5}$	Adult premature mortality based on cohort study estimates and expert elicitation estimates (age 65-99 or age 30-99)	✓	PM ISA
	Infant mortality (age <1)	✓	PM ISA
Nonfatal morbidity from exposure to $PM_{2.5}$	Heart attacks (age > 18)	✓	PM ISA
	Hospital admissions—cardiovascular (ages 65-99)	✓	PM ISA
	Emergency department visits— cardiovascular (age 0-99)	✓	PM ISA
	Hospital admissions—respiratory (ages 0-18 and 65-99)	✓	PM ISA
	Emergency room visits—respiratory (all ages)	✓	PM ISA
	Cardiac arrest (ages 0-99; excludes initial hospital and/or emergency department visits)	✓	PM ISA
	Stroke (ages 65-99)	✓	PM ISA
	Asthma onset (ages 0-17)	✓	PM ISA
	Asthma symptoms/exacerbation (6-17)	✓	PM ISA
	Lung cancer (ages 30-99)	✓	PM ISA
	Allergic rhinitis (hay fever) symptoms (ages 3-17)	✓	PM ISA
	Lost work days (age 18-65)	✓	PM ISA
	Minor restricted-activity days (age 18-65)	✓	PM ISA
	Hospital admissions—Alzheimer's disease (ages 65-99)	✓	PM ISA
	Hospital admissions—Parkinson's disease (ages 65-99)	✓	PM ISA
	Other cardiovascular effects	✓	PM ISA
	Other respiratory effects	✓	PM ISA
	Other nervous system effects	✓	PM ISA
	Cancer	✓	PM ISA
	Reproductive and developmental effects	—	PM ISA
	Metabolic effects	—	PM ISA
Mortality from exposure to ozone	Premature respiratory mortality based on short-term study estimates (0-99)	✓	Ozone ISA
	Premature respiratory mortality based on long-term study estimates (age 30–99)	✓	Ozone ISA
Nonfatal morbidity from exposure to ozone	Hospital admissions—respiratory (ages 0-99)	✓	Ozone ISA
	Emergency department visits—respiratory (ages 0-99)	✓	Ozone ISA
	Asthma onset (0-17)	✓	Ozone ISA
	Asthma symptoms/exacerbation (asthmatics age 2-17)	✓	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
	Metabolic effects (*e.g.*, diabetes)	✓	Ozone ISA

For regulatory analyses, the Agency estimated changes in health effects in response to modeled air quality changes for each health endpoint identified as causal or likely-to-be-causal in Table 4-1. The environmental Benefits Mapping and Analysis Program—Community Edition (BenMAP-CE) software program was used to quantify counts of premature deaths and illnesses attributable to photochemical modeled changes in annual mean $PM_{2.5}$ and summer season average ozone. This approach to estimating health impacts involved two major steps: (1) developing spatial fields of air quality across the U.S. for the baseline and regulatory scenarios using nationwide photochemical source apportionment modeling and related analyses; and (2) using these spatial fields in BenMAP-CE to quantify selected endpoints under each scenario and each year as compared to the baseline in that year while accounting for the changes in population size, income growth, and baseline incidence and prevalence rates.

Figure 4-1 summarizes the key data inputs and modeling steps for estimating the health impacts of a regulatory impact analysis using $PM_{2.5}$ inputs as an example.

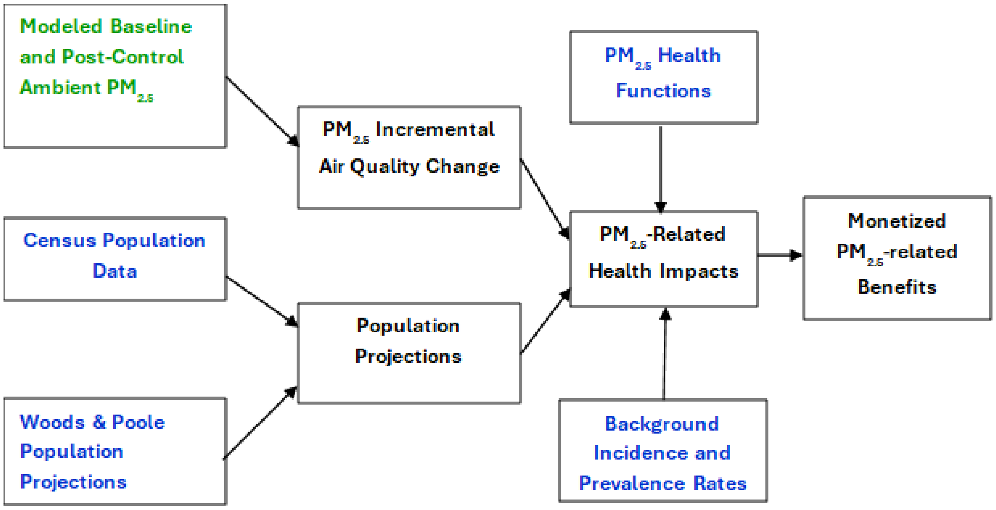

Figure 4-1 **Data Inputs and Outputs for the BenMAP-CE Model Using $PM_{2.5}$ as an Example**

As the diagram above illustrates, the approach for estimating $PM_{2.5}$ and O_3 benefits included health effect risk estimates from epidemiologic studies, population data, population growth estimates, economic data for monetizing risk reductions, and assumptions regarding the future state of the world (*e.g.*, on-the-books regulations). Each of these inputs has unique uncertainties associated with it. When the uncertainties from each stage of the analysis are compounded, even small uncertainties can have large effects on the total quantified benefits. Where possible, the EPA in the past has attempted to quantitatively assess uncertainty in each input parameter. In some cases, quantitative analysis has not been possible due to lack of data, so the Agency instead characterized the sensitivity of the results to alternative plausible input parameters. And, for some inputs into the benefits analysis, such as the air quality data, we lacked the data to perform either a quantitative uncertainty analysis or sensitivity analysis.

Throughout prior regulatory impact analyses, the EPA acknowledged these significant uncertainties around input parameters and employed various techniques for characterizing the resulting uncertainty in estimates of regulatory impacts. For example, the Agency has estimated the fraction of avoided health effects occurring at various concentration ranges, conducted sensitivity analyses, and employed alternate concentration-response assumptions to show how much estimates could vary depending on which assumptions and inputs were used in primary estimates vs. sensitivity estimates.

Chapter 6 of the EPA Health Benefits TSD, Estimating PM2.5- and Ozone-Attributable Health Benefits: 2024 Update, details our approach to characterizing uncertainty associated with the estimation of $PM_{2.5}$ and O_3 benefits in both quantitative and qualitative terms.[38] Some of the key types of uncertainty highlighted in this chapter include:

- Statistical uncertainty around the risk estimate
- Uncertainty around low concentration exposures and the potential for thresholds
- Uncertainty in exposure estimates
- Co-pollutant confounding
- Confounding by other individual risk factors
- Effect modification
- Application of risk estimates to other locations and populations
- Uncertainties regarding at-risk populations
- Baseline incidence rate uncertainties
- Economic valuation estimate uncertainties (*e.g.,* income elasticity of willingness to pay, statistical estimates of VSL, Alzheimer's and Parkinson's onset lifetime costs)
- Unquantified uncertainties (*e.g.,* causality determination, estimating and assigning exposures in epidemiology studies, risk attributable to long-term and short-term exposures, shape of the concentration-response relationship)

Despite substantial investments by the EPA in approaches to characterizing uncertainties, the regulatory impact analyses have still tended to focus on point estimates for PM2.5 and ozone-related benefits. Frequently, the Agency has utilized more than one epidemiologic study to

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[38] U.S. EPA. (2024a). Estimating PM2.5- and Ozone-Attributable Health Benefits: 2024 Update. https://www.epa.gov/system/files/documents/2024-06/estimating-pm2.5-and-ozone-attributable-health-benefits-tsd-2024.pdf.

estimate mortality impacts because these estimates drive overall benefits for a given regulatory action due to the large monetary value assigned to such impacts. Risk estimates using the top epidemiologic studies sometimes differ by a factor of two or more. Presenting multiple estimates drawn directly from the primary literature is one way to convey the prevailing uncertainty. While this leads to an estimated range of benefits, it is not a range that reflects the true uncertainties in the underlying parameters supporting each study, either for mortality or for other effects. Because of the significant impacts of environmental regulations on the U.S. economy, it is essential that the Agency have confidence in the estimated benefits of an action, and their underlying uncertainties, prior to utilizing these estimates in a regulatory context.

A 2024 Scientific Advisory Board reviewed EPA's methods for estimating the health effects of $PM_{2.5}$ and clearly and repeatedly recommended that EPA improve its approach to characterizing and presenting the uncertainty in estimating the health effects of $PM_{2.5}$.[39] A Tier 1 SAB recommendation was that the EPA present a single probabilistic mortality estimate based on pooled risk estimates with associated uncertainty ranges rather than present multiple estimates of mortality outcomes from the epidemiologic studies. EPA was encouraged to explore meta-analysis methods or other forms of information synthesis, and support research and development of modified methods as needed.

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[39] U.S. EPA-SAB. (2024). Review of BenMAP and Benefits Methods (EPA-SAB-24-003). https://sab.epa.gov/ords/sab/r/sab_apex/sab/advisoryreports.

The OMB "2017 Report to Congress on the Benefits and Costs of Federal Regulations" listed six key assumptions underpinning $PM_{2.5}$ health effect estimation which introduce substantial uncertainties in the health effect estimates:[40]

1. That inhalation of fine particles is causally associated with premature death at concentrations near those experienced by most Americans on a daily basis;
2. That the concentration-response function for fine particles and premature mortality is approximately linear, even for concentrations below the levels established by the NAAQS;
3. That all fine particles, regardless of their chemical composition, are equally potent in causing premature mortality;
4. That the forecasts for future emissions and associated air quality modeling accurately predict both the baseline (state of the world absent a rule) and the air quality impacts of the rule being analyzed;
5. That BPT approaches, when used to estimate benefits, are based on regional or national-level analysis that may not reflect local variability in population density, meteorology, exposure, baseline health incidence rates, or other local factors; and
6. That the estimated value of mortality risk reductions is an accurate reflection of what people would be willing to pay for incremental reductions in mortality risk from air pollution exposure, and that these values are constant across the life-cycle.

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[40] OMB. (2017). 2017 Report to Congress on the Benefits and Costs of Federal Regulations and Agency Compliance with the Unfunded Mandates Reform Act. https://trumpwhitehouse.archives.gov/wp-content/uploads/2019/12/2019-CATS-5885-REV_DOC-2017Cost_BenefitReport11_18_2019.docx.pdf.

To the extent that any of these assumptions is incorrect, the benefit estimates will change, though the magnitude and direction of change are not known with certainty. The EPA is interested in improving understanding in each of these six areas. EPA understands that additional research is needed, and will begin to develop approaches that reduce these uncertainties. The EPA will seek peer review for new methods developed from this work consistent with the OMB's Peer Review Guidance.[41]

In particular, the EPA is interested in reevaluating the validity of the approach for estimating the benefits of air quality improvements relative to the National Ambient Air Quality Standards (NAAQS) for $PM_{2.5}$ and ozone. These standards, which have been set at a level which the Administrator judges to be requisite to protect public health or welfare with an adequate margin of safety, are widely understood to represent the divide between clean air and air with an unacceptable level of pollution. Even in instances where an assumption is found to be justified based on scientific evidence, the EPA is interested in reevaluating its approach to characterizing and communicating underlying uncertainty to the public.

In the past, the EPA has explored a variety of approaches to shed light on how the estimated benefits of an action relate to the level of the NAAQS. For example, in estimating PM benefits, the Agency has employed techniques such as cutpoint analyses and Lowest Measured Level analyses, noting that we are most confident in the magnitude of the risks we project at $PM_{2.5}$ concentrations that coincide with the bulk of the observed $PM_{2.5}$ concentrations in the epidemiological studies that are used to estimate the benefits (Regulatory Impact Analysis for the Repeal of the Clean Power Plan, and the Emission Guidelines for Greenhouse Gas Emissions

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[41] OMB. (2005). Memorandum M-05-03, Memorandum for the Heads of Executive Departments and Agencies: Issuance of OMB's Final Information Quality Bulletin for Peer Review. *Federal Register*. https://www.govinfo.gov/content/pkg/FR-2005-01-14/pdf/05-769.pdf.

from Existing Electric Utility Generating Units, Section 4.4.4, p. 4-26).[42] However, such approaches address only a few of the sources of uncertainty that influence PM-related air quality benefits.

The limitations of reduced-form approaches, such as the BPT approach are even more pronounced than photochemical modeling/BenMAP-CE approaches due to: 1) the compounding effects of emissions reductions typically occurring across many geographic areas simultaneously, with varying proximity to population centers; 2) differing atmospheric transformation pathways for nitrous oxides (NO_x), volatile organic compounds (VOCs), and secondary $PM_{2.5}$; and 3) region-specific photochemical and meteorological conditions. Using a national BPT estimate implicitly assumes uniform marginal health benefits for each ton of reduced emissions, an assumption not supported given heterogeneity in exposure patterns and atmospheric chemistry. As more areas achieve or maintain attainment with the NAAQS, the uncertainties associated with low-concentration health effects grow, and marginal benefits become more difficult to characterize with precision.

Therefore, it may be appropriate for the EPA to separate exposures and impacts above the level of the standard from those occurring at lower ambient concentrations. The EPA will investigate this prior to estimating these impacts in a regulatory analysis even for informational purposes.

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[42] U.S. EPA. (2019c). Regulatory Impact Analysis for the Repeal of the Clean Power Plan, and the Emission Guidelines for Greenhouse Gas Emissions from Existing Electric Utility Generating Units (EPA-452/R-19-003). https://www.epa.gov/sites/default/files/2019-06/documents/utilities_ria_final_cpp_repeal_and_ace_2019-06.pdf.

4.2.1 Human Health Effects

We did not quantify the human health effects of changes in emissions of CO, NO_X, SO_2, $PM_{2.5}$, or ambient ozone concentrations for this rule. A qualitative description of related human health effects is provided instead.

4.2.1.1 CO-Related Health Effects

The *Integrated Science Assessment for Carbon Monoxide* (CO ISA) reviewed toxicological, clinical, and epidemiological evidence from scientific studies on the health effects of exposure to CO and concluded that there is a likely causal relationship between cardiovascular morbidity and short-term exposure to CO.[43] The CO ISA found compelling evidence from controlled human exposure studies that there was a CO-induced effect on the incidence of exercise-induced angina and ST-segment changes among individuals with coronary artery disease. The CO ISA noted that while the exact physiological significance of the observed ST-segment changes is uncertain, ST-segment depression is a known indicator of myocardial ischemia. The epidemiologic evidence was consistent with the results of the controlled human exposure studies, finding positive associations between ambient CO concentration and emergency department visits and hospital admissions for ischemic heart disease, congestive heart failure, and cardiovascular diseases generally. The CO ISA found weaker causal relationships between CO exposure and other health effects categories.

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[43] U.S. EPA. (2010). Integrated Science Assessment for Carbon Monoxide (EPA/600/R-09/019F). https://www.epa.gov/isa/integrated-science-assessment-isa-carbon-monoxide.

4.2.1.2 NO_x-Related Health Effects

The *Integrated Science Assessment for Oxides of Nitrogen – Health Criteria* (NO_X ISA) reviewed evidence from epidemiologic and laboratory studies on the health effects of exposure to NO_X, concluding that there is a likely causal relationship between respiratory health effects and short-term exposure to NO_2.[44] Epidemiologic and experimental studies encompassed several endpoints including emergency department visits and hospitalizations, respiratory symptoms, airway hyperresponsiveness, airway inflammation, and lung function. The NO_X ISA also concluded that the relationship between short-term NO_2 exposure and premature mortality was "suggestive but not sufficient to infer a causal relationship," because it is difficult to attribute the mortality risk effects to NO_2 alone. Although the NO_X ISA stated that studies consistently reported a relationship between NO_2 exposure and mortality, the effect was generally smaller than that for other pollutants such as PM. NO_X emissions are also a precursor to ozone and $PM_{2.5}$ and may affect human health through these additional pathways.

4.2.1.3 SO_2-Related Health Effects

The *Integrated Science Assessment for Oxides of Sulfur – Health Criteria* (SO_2 ISA) reviewed evidence from epidemiologic and laboratory studies on health effects of exposure to SO_2, concluding that there is a causal relationship between respiratory health effects and short-term exposure to SO_2.[45] The immediate effect of SO_2 on the respiratory system in humans is bronchoconstriction. Asthmatics are more sensitive to the effects of SO_2 likely resulting from pre-existing inflammation associated with this disease. A clear concentration-response

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[44] U.S. EPA. (2016b). Integrated Science Assessment for Oxides of Nitrogen - Health Criteria (EPA/600/R-15/068). https://www.epa.gov/isa/integrated-science-assessment-isa-oxides-nitrogen-health-criteria.

[45] U.S. EPA. (2017). Integrated Science Assessment for Sulfur Oxides - Health Criteria (EPA/600/R-17/451). https://www.epa.gov/isa/integrated-science-assessment-isa-sulfur-oxides-health-criteria.

relationship has been demonstrated in laboratory studies following exposures to SO_2 at concentrations between 20 and 100 ppb, both in terms of increasing severity of effect and percentage of asthmatics adversely affected. Based on the EPA's review of this information, we identified three short-term morbidity endpoints that the SO_2 ISA identified as a "causal relationship": asthma exacerbation, respiratory-related emergency department visits, and respiratory-related hospitalizations. The differing evidence and associated strength of the evidence for these different effects is described in detail in the SO_2 ISA. The SO_2 ISA also concluded that the relationship between short-term SO_2 exposure and premature mortality was "suggestive of a causal relationship" because it is difficult to attribute the mortality risk effects to SO_2 alone. Although the SO_2 ISA stated that studies are generally consistent in reporting a relationship between SO_2 exposure and mortality, there was a lack of robustness of the observed associations to adjustment for other pollutants SO_2 emissions are also a precursor to $PM_{2.5}$ and may affect human health through this additional pathway.

4.2.1.4 Ozone-Related Health Effects

Following a comprehensive review of toxicological, clinical, and epidemiological evidence, the *Integrated Science Assessment for Ozone and Related Photochemical Oxidants* (Ozone ISA) found both short-term (*i.e.*, less than one month) and long-term (*i.e.*, one month or longer) ozone exposure to be related to an array of adverse human health effects.[46] For each effect, the Ozone ISA reports relationships 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. This assessment is based on the body of scientific evidence which can

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[46] U.S. EPA. (2020). Integrated Science Assessment for Ozone and Related Photochemical Oxidants (EPA/600/R-20/012). https://www.epa.gov/isa/integrated-science-assessment-isa-ozone-and-related-photochemical-oxidants.

include observational human studies, experimental human exposure studies, animal model studies, and mechanistic studies.

The Ozone ISA found short-term exposure to ozone to be causally related to respiratory effects, including respiratory mortality, and likely to be causally related to metabolic effects. For short-term exposure, evidence was suggestive of a causal relationship for cardiovascular and nervous system effects as well as total mortality. The Ozone ISA reported that long-term exposure to ozone is likely-to-be-causally related to respiratory effects, including respiratory mortality. Evidence on metabolic, cardiovascular, reproductive, and nervous system effects as well as total mortality was suggestive of a causal relationship with long-term ozone exposure.

When adequate data and resources are available, the EPA has generally quantified health effects which the Ozone ISA classified as causally related or likely-to-be-causally related to short- or long-term ozone exposure. Health effects classified as suggestive-of-causality or weaker have not historically been quantified. Historically quantified health effects include premature respiratory mortality, hospital admissions and emergency department visits, asthma onset and related symptoms (chest tightness, cough, shortness of breath, and wheeze), allergic rhinitis symptoms, as well as restricted activity days and school absences. The EPA did not quantify or monetize the benefits or disbenefits associated with changes in the incidence of the listed health effects for this rule.

4.2.1.5 $PM_{2.5}$-Related Health Effects

$PM_{2.5}$ describes an array of pollutants from human and natural sources which occur in a common size range. This includes directly emitted $PM_{2.5}$ as well as $PM_{2.5}$ formed through atmospheric chemical reactions of precursor pollutants including NO_X and SO_2.

The *Integrated Science Assessment for Particulate Matter* (PM ISA) and the *Supplement to the Integrated Science Assessment for Particulate Matter* (PM ISA Supplement) found $PM_{2.5}$ to be related to an array of adverse human health effects.[47, 48] For each effect, the PM ISA and PM ISA Supplement report relationships 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. This assessment is based on the body of scientific evidence which can include observational human studies, experimental human exposure studies, animal model studies, and mechanistic studies.

The PM ISA and PM ISA Supplement found acute and chronic exposures to $PM_{2.5}$ to be causally related to cardiovascular effects and total mortality (*i.e.*, premature death), and respiratory effects as likely-to-be-causally related. Chronic exposures to $PM_{2.5}$ were also determined to be likely-to-be-causally related to nervous system effects and cancer, with the latter determination based primarily on evidence from studies of lung cancer incidence as well as decades of research on the mutagenicity and carcinogenicity of PM. Evidence was suggestive of a causal relationship for reproductive and developmental effects, pregnancy and birth outcomes, and metabolic effects.

When adequate data and resources are available, the EPA has generally quantified health effects which the PM ISA and PM ISA Supplement classified as causally related or likely-to-be-causally related to $PM_{2.5}$ exposure. Health effects classified as suggestive-of-causality or weaker have not historically been quantified. Historically quantified health effects include premature

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[47] U.S. EPA. (2019b). Integrated Science Assessment for Particulate Matter (EPA/600/R-19/188). Retrieved from: https://www.epa.gov/isa/integrated-science-assessment-isa-particulate-matter.

[48] U.S. EPA. (2022). Supplement to the 2019 Integrated Science Assessment for Particulate Matter (EPA/600/R-22/028). https://www.epa.gov/isa/integrated-science-assessment-isa-particulate-matter.

respiratory mortality, heart attacks, cardiovascular hospital admissions, cardiovascular emergency department visits, respiratory hospital admissions, respiratory emergency room visits, cardiac arrest, stroke, asthma onset, asthma symptoms/exacerbation, lung cancer, allergic rhinitis (hay fever) symptoms, lost workdays, minor restricted-activity days, Alzheimer's disease hospital admissions, and Parkinson's disease hospital admissions. The EPA did not quantify or monetize the benefits or disbenefits associated with changes in the incidence of the listed health effects for this rule.

4.2.2 *Welfare Effects of Ozone and $PM_{2.5}$*

Due to operational constraints and data limitations, most benefits analyses focus on human health effects expected to occur because of changes in pollutant concentrations resulting from the rulemaking; however, the benefits of reductions in emissions of air pollutants include additional effects that extend beyond direct impacts to economic interests.

The Clean Air Act encourages consideration of the welfare effects of air pollutants, which it defines as including, but not limited to, effects on soils, water, crops, vegetation, manmade materials, animals, wildlife, weather, visibility, and climate, damage to and deterioration of property, and hazards to transportation, as well as effects on economic values and on personal comfort and well-being, whether caused by transformation, conversion, or combination with other pollutants (42 U.S.C. §7602(h)). In this section, we provide qualitative discussions of select welfare effects.

4.2.2.1 Ozone-Related Vegetation and Ecosystem Effects

Exposure to ozone has been found to be associated with a wide array of vegetation and ecosystem effects in the published literature.[49] 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, changes to species composition, and changes in ecosystems and associated ecosystem services.[50]

4.2.2.2 $PM_{2.5}$-Related Visibility Effects

Reducing formation of $PM_{2.5}$ improves levels of visibility in the U.S. because suspended particles and gases degrade visibility by scattering and absorbing light.[51] Fine particles with significant light-extinction efficiencies include sulfates, nitrates, organic carbon, elemental carbon, and soil. Visibility has direct significance to people's enjoyment of daily activities and their overall sense of wellbeing. Good visibility increases the quality of life where individuals live and work, and where they engage in recreational activities. Particulate sulfate is the dominant source of regional haze in the eastern U.S. and particulate nitrate is an important

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[49] U.S. EPA. (2020). Integrated Science Assessment for Ozone and Related Photochemical Oxidants (EPA/600/R-20/012). https://www.epa.gov/isa/integrated-science-assessment-isa-ozone-and-related-photochemical-oxidants.

[50] U.S. EPA. (2020). Integrated Science Assessment for Ozone and Related Photochemical Oxidants (EPA/600/R-20/012). https://www.epa.gov/isa/integrated-science-assessment-isa-ozone-and-related-photochemical-oxidants.

[51] U.S. EPA. (2019b). Integrated Science Assessment for Particulate Matter (EPA/600/R-19/188). Retrieved from: https://www.epa.gov/isa/integrated-science-assessment-isa-particulate-matter.

contributor to light extinction in California.[52] Previous analyses show that visibility benefits can be a significant welfare benefit category.[53]

4.2.2.3 Animal Welfare Effects

While effects can be context- and species-specific, a large body of scientific evidence links ozone exposure to health effects in animals. When exploring environmental pathways through which environmental effects of ozone may impact animals, the Ozone ISA found a likely-to-be-causal relationship between ambient ozone concentrations and alterations of herbivore growth and reproduction.[54, 55,56, 57, 58] In addition, many animal toxicological studies served as evidence for determining the causality of relationships between human exposure to ozone and human health effects, including respiratory and metabolic effects. The Ozone ISA states, "A large body of experimental animal toxicological studies demonstrates (short- and long-term) ozone-induced changes in measures of lung function, inflammation, increased airway responsiveness, and impaired lung host defense." Additionally, animal studies report

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[52] U.S. EPA. (2019b). Integrated Science Assessment for Particulate Matter (EPA/600/R-19/188). Retrieved from: https://www.epa.gov/isa/integrated-science-assessment-isa-particulate-matter.

[53] For example, see U.S. EPA. (2012). Regulatory Impact Analysis for the Final Revisions to the National Ambient Air Quality Standards for Particulate Matter (EPA-452/R-12-005). https://www3.epa.gov/ttnecas1/regdata/RIAs/finalria.pdf.

[54] Girón-Calva, P. S., et al. (2016). Plant-plant interactions affect the susceptibility of plants to oviposition by pests but are disrupted by ozone pollution. *Agriculture, Ecosystems & Environment*, 233, 352-360. https://doi.org/10.1016/j.agee.2016.09.028.

[55] Habeck, C. W., & Lindroth, R. L. (2013). Influence of global atmospheric change on the feeding behavior and growth performance of a mammalian herbivore, Microtus ochrogaster. *PLoS One*, 8(8), e72717. https://doi.org/10.1371/journal.pone.0072717.

[56] Hong, Y., et al. (2016). High Ozone (O(3)) Affects the Fitness Associated with the Microbial Composition and Abundance of Q Biotype Bemisia tabaci. *Front Microbiol*, 7, 1593. https://doi.org/10.3389/fmicb.2016.01593.

[57] U.S. EPA. (2020). Integrated Science Assessment for Ozone and Related Photochemical Oxidants (EPA/600/R-20/012). https://www.epa.gov/isa/integrated-science-assessment-isa-ozone-and-related-photochemical-oxidants.

[58] Ueno, A. C., et al. (2015). Mutualism effectiveness of a fungal endophyte in an annual grass is impaired by ozone. *Functional Ecology*, 30(2), 226-234. https://doi.org/10.1111/1365-2435.12519.

relationships between short-term ozone exposure and metabolic effects in various stocks and strains of animals across multiple laboratories.[59, 60, 61, 62]

The PM ISA and PM ISA Supplement evaluated relationships exposures to $PM_{2.5}$ and an array of health markers described in animal toxicological studies.[63, 64] Animal toxicological studies have found evidence that $PM_{2.5}$ induces changes in measurements including but not limited to breathing patterns,[65] airway irritation,[66] impaired heart function,[67] changes in blood

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[59] Gordon, C. J., et al. (2017). Active vs. sedentary lifestyle from weaning to adulthood and susceptibility to ozone in rats. *Am J Physiol Lung Cell Mol Physiol*, 312(1), L100-L109. https://doi.org/10.1152/ajplung.00415.2016.

[60] Miller, D. B., et al. (2015). Inhaled ozone (O3)-induces changes in serum metabolomic and liver transcriptomic profiles in rats. *Toxicol Appl Pharmacol*, 286(2), 65-79. https://doi.org/10.1016/j.taap.2015.03.025.

[61] U.S. EPA. (2020). Integrated Science Assessment for Ozone and Related Photochemical Oxidants (EPA/600/R-20/012). https://www.epa.gov/isa/integrated-science-assessment-isa-ozone-and-related-photochemical-oxidants.

[62] Ying, Z., et al. (2016). Subacute inhalation exposure to ozone induces systemic inflammation but not insulin resistance in a diabetic mouse model. *Inhal Toxicol*, 28(4), 155-163. https://doi.org/10.3109/08958378.2016.1146808.

[63] U.S. EPA. (2019b). Integrated Science Assessment for Particulate Matter (EPA/600/R-19/188). Retrieved from: https://www.epa.gov/isa/integrated-science-assessment-isa-particulate-matter.

[64] U.S. EPA. (2022). Supplement to the 2019 Integrated Science Assessment for Particulate Matter (EPA/600/R-22/028). https://www.epa.gov/isa/integrated-science-assessment-isa-particulate-matter.

[65] Diaz, E. A., et al. (2012). Effects of fresh and aged traffic-related particles on breathing pattern, cellular responses, and oxidative stress. *Air Quality, Atmosphere & Health*, 6(2), 431-444. https://doi.org/10.1007/s11869-012-0179-2.

[66] Nikolov, M. C., et al. (2008). Statistical Methods to Evaluate Health Effects Associated with Major Sources of Air Pollution: A Case-Study of Breathing Patterns During Exposure to Concentrated Boston Air particles. *Journal of the Royal Statistical Society Series C: Applied Statistics*, 57(3), 357-378. https://doi.org/10.1111/j.1467-9876.2008.00618.x.

[67] Kurhanewicz, N., et al. (2014). Ozone co-exposure modifies cardiac responses to fine and ultrafine ambient particulate matter in mice: concordance of electrocardiogram and mechanical responses. *Part Fibre Toxicol*, 11, 54. https://doi.org/10.1186/s12989-014-0054-4.

pressure,[68] oxidative stress,[69, 70] reproductive outcomes ,[71, 72, 73] and other outcomes.[74, 75] However, neither the PM ISA nor the PM ISA Supplement provide a causality determination of the causality of $PM_{2.5}$ affecting animal health endpoints.

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[68] Wagner, J. G., et al. (2014). PM2.5-induced cardiovascular dysregulation in rats is associated with elemental carbon and temperature-resolved carbon subfractions. *Part Fibre Toxicol*, 11, 25. https://doi.org/10.1186/1743-8977-11-25.

[69] Davel, A. P., et al. (2012). Endothelial dysfunction in the pulmonary artery induced by concentrated fine particulate matter exposure is associated with local but not systemic inflammation. *Toxicology*, 295(1-3), 39-46. https://doi.org/10.1016/j.tox.2012.02.004.

[70] Ghelfi, E., et al. (2010). Cardiac oxidative stress and dysfunction by fine concentrated ambient particles (CAPs) are mediated by angiotensin-II. *Inhal Toxicol*, 22(11), 963-972. https://doi.org/10.3109/08958378.2010.503322.

[71] de Melo, J. O., et al. (2015). Inhalation of fine particulate matter during pregnancy increased IL-4 cytokine levels in the fetal portion of the placenta. *Toxicol Lett*, 232(2), 475-480. https://doi.org/10.1016/j.toxlet.2014.12.001.

[72] Pires, A., et al. (2011). Pre- and postnatal exposure to ambient levels of urban particulate matter (PM(2.5)) affects mice spermatogenesis. *Inhal Toxicol*, 23(4), 237-245. https://doi.org/10.3109/08958378.2011.563508.

[73] Veras, M. M., et al. (2012). The effects of particulate ambient air pollution on the murine umbilical cord and its vessels: a quantitative morphological and immunohistochemical study. *Reprod Toxicol*, 34(4), 598-606. https://doi.org/10.1016/j.reprotox.2012.08.003.

[74] U.S. EPA. (2019b). Integrated Science Assessment for Particulate Matter (EPA/600/R-19/188). Retrieved from: https://www.epa.gov/isa/integrated-science-assessment-isa-particulate-matter.

[75] U.S. EPA. (2022). Supplement to the 2019 Integrated Science Assessment for Particulate Matter (EPA/600/R-22/028). https://www.epa.gov/isa/integrated-science-assessment-isa-particulate-matter.

5 ECONOMIC IMPACT ANALYSIS

We estimate that the final amendments to the NESHAP for Plywood and Composite Wood Products will result in total capital investment greater than $120 million and total annual costs greater than $40 million per year. However, the engineering cost analysis does not fully capture the potential economic and distributional impacts of the final amendments.

To more thoroughly assess the economic and distributional impacts of a rule, the EPA often prepares a partial equilibrium analysis or, when appropriate, a screening analysis. In a partial equilibrium analysis, the EPA estimates how compliance costs affect the regulated industry and any closely related industries, while assuming that impacts on other industries are zero or so inconsequential as to not be considered in the analysis.[76] This approach can provide a detailed summary of changes in the markets for the goods or services produced by the industries most affected by the rule, including how producers and consumers respond to increased regulatory costs. However, partial equilibrium analysis can be resource intensive and may be deemed unnecessary when compliance costs are relatively small either on a per-unit basis or as a percentage of industry revenues. In such a case, a screening analysis may be conducted to examine the relative magnitude of compliance costs. One screening analysis method, called the cost-to-revenue test or cost-to-sales test (the "sales test"), consists of calculating annualized costs as a percentage of sales for affected parent companies, representing the maximum price increase in the affected product or service needed to completely recover the costs of compliance. The method assumes that the impacts of a rule are solely incident on either directly affected firms with no impacts on consumers or on consumers with no impacts on producers. While not as

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[76] U.S. EPA. (2024b). Guidelines for Preparing Economic Analyses (3rd edition) (EPA-240-R-24-001). https://www.epa.gov/environmental-economics/guidelines-preparing-economic-analyses-3rd-edition.

nuanced as a partial equilibrium analysis in its lack of distributional considerations, the sales test nonetheless provides an upper-bound estimate for the change in costs borne either by producers or consumers that is expected to result from the rulemaking.

In this chapter, we present the results from both a partial equilibrium economic model and a screening analysis. The screening analysis was conducted to specifically focus on potential impacts on small businesses. This chapter also includes a discussion about possible employment impacts. Because benefits were neither quantified nor monetized, an estimate of the net change in social welfare resulting from this rulemaking is not presented.

5.1 PARTIAL EQUILIBRIUM MODELING OF THE U.S. PCWP MARKET

5.1.1 Modeling Approach

The EPA modeled the impacts of increased environmental control costs impacting plywood and composite wood products using a standard partial equilibrium model linking the market for industrial roundwood (felled wood prior to processing) to the downstream markets for sawnwood (lumber), plywood/veneer, particleboard/oriented strandboard, and fiberboard (which includes medium density fiberboard, high-density fiberboard, hardboard, and other varieties of fiberboard). We linked these markets by specifying the interactions between supply and demand for products in each market and solving for the equilibrium prices and quantities across all markets simultaneously. All four downstream wood products share a common upstream input, so compliance cost shocks propagate across sectors simultaneously.

The model also represents international trade flows to capture how wood products markets are likely to adjust when domestic production costs are increased by regulatory compliance requirements. The US is both an exporter and importer across wood product categories, so trade flows are likely an important channel through which regulatory compliance cost shocks are transmitted and absorbed.

When regulatory compliance costs rise, increased import competition offsets some of the price impact on domestic consumers, while higher costs also affect the competitiveness of US producers in export markets. Understanding how these trade responses mediate market impacts is important for understanding how regulatory costs may affect the sector.

The PE modeling framework used in this EIA treats domestic and imported wood products as imperfect substitutes, reflecting potential quality differences between different sources of wood products. On the supply side, producers shift output between domestic and export markets in response to relative prices, capturing how compliance costs affect competitiveness on both margins.

5.1.1.1 Background and Preliminaries

This section presents the static (single-period) partial equilibrium model, which is characterized by iso-elastic demand and supply for each sector, including import supply from foreign producers and export demand from foreign markets. We describe the model at a high level and introduce notation. Subsequent sections fill in the details.

The supply of each wood product (indexed by i) comes from domestic producers and imports. The model characterizes domestic supply of each wood product at the national level as coming from a single representative supplier whose production is represented by a supply curve with a constant price elasticity. Similarly, imports of each wood product are produced by a representative international supplier whose production is represented by a supply curve with a constant price elasticity η_{im}. The allocation of domestic production between domestic and export sales is responsive to relative prices, with the responsiveness of the allocation to prices represented by a constant elasticity of transformation (CET) function governed by parameter τ.

Demand for industrial roundwood (RW) comes from domestic producers of downstream wood products and demand for exports. The downstream wood products considered in the model are sawnwood (SW), plywood/veneer (PW), particleboard/oriented strandboard (PB), and fiberboard (FB). We assume each downstream product uses a fixed quantity of RW per unit output. Domestic demand for each downstream wood product is characterized by a demand curve with a constant price elasticity. We characterize demand for exports of each wood product by a demand curve with a constant price elasticity.

Demand for each wood product is differentiated between demand for domestic production and demand for imported production. Domestic consumers allocate consumption between the domestic and imported varieties based on relative prices, with price-responsiveness represented by a constant elasticity of substitution function governed by the parameter σ_p. Total demand for each wood product is represented by a constant-price elasticity demand function, as described above. Total demand responds to changes in the price index of the composite wood product variety. Conditional on total demand, consumers allocate spending to the domestic and imported based on the relative prices of domestic and imported production and underlying preferences for each type of product. The allocation of demand between domestic and imported wood products is described in further detail below.

Each wood product may receive a compliance cost shock that represents the per-unit change in compliance cost in the modeled scenario. This compliance cost shock (if non-zero) shifts a given wood product's representative domestic supply curve. The model then solves for a set of prices that balances domestic production with demand for domestic production and import supply with import demand across all wood products. Table 5-1 describes the notation that will be used to describe the model in subsequent sections. Equations in the model are calibrated using values of variables in a representative baseline year (2022). Baseline values are referenced with 0 in the subscript (*i.e.*, X_0).

Table 5-1 Plywood and Wood Composites Model Notation

Symbol	Description
RW	Industrial Roundwood
SW	Sawnwood
PW	Plywood/Veneer
PB	Particleboard/Oriented Strandboard
FB	Fiberboard
p	Set of wood products = {RW, SW, PW, FB, PB}
i	Set of input products = {RW}
j	Set of output products = {SW, PW, PB, FB}
Model Variables	
$P_{pc}, PP_p, P_{pd}, P_{pm}, P_{pd}, P_{px}$	Prices: domestic/imported composite price index, producer supply price index, domestic production, imported production, exported sales
dP_i	Change in the price of input i
Q_{Dp}, Q_{Dpd}, Q_{Dpm}	Total quantity demanded, quantity demanded of the domestic variety, quantity demanded of the imported variety
$Q_{Sp}, Q_{Spd}, QSD_p, QSX_p$	Total quantity supplied, total domestic production, domestic supply for domestic sales, domestic supply for exported sales
M_p	Imports
X_p	Exports
Model Parameters	
$\epsilon_{jd}, \epsilon_{px}$	Price elasticity of total demand for product j, price elasticity of export demand for product p
η_{pd}, η_{pm}	Price elasticity of domestic supply, price elasticity of import supply
A_{ij}	The quantity of product i used in production of product j
σ_p, τ_p	Armington elasticity of substitution between domestic and imported varieties; Elasticity of transformation between domestic and exported sales
θ_p, γ_p	Value share of domestic variety in baseline domestic consumption; Value share of domestic sales in baseline domestic production
c_j	Compliance cost shock impacting product j

5.1.1.2 Supply

Market supply of each wood product is composed of domestic production and imports:

$$\mathrm{Q}_{Sp} = Q_{Spd} + M_p.$$

Domestic supply is represented by a set of constant elasticity supply curves. Domestic supply curves differ based on the form of the cost shock faced by the product. The input product RW can in principle receive a regulatory compliance cost shock, but these products are not directly affected by this regulatory action. Output products face direct regulatory compliance cost shocks under this rulemaking and indirect cost shocks caused by changes to input prices. The domestic supply curves are as follows:

$$Q_{Sid} = Q_{Sid0} \cdot \left(\frac{PP_i - c_i}{P_{id0}}\right)^{\eta_{\mathrm{id}}}$$

and

$$Q_{Sjd} = Q_{Sjd0} \cdot \left(\frac{PP_j - \mathrm{dP}_{\mathrm{RW,c}} \cdot A_{RW,j} - c_j}{P_{jd0}}\right)^{\eta_{\mathrm{jd}}}.$$

Domestic suppliers adjust output based on the change in their producer price net of cost shocks, which can include per-unit compliance cost shocks and changes to input prices. The per-unit compliance cost shock is calculated by dividing estimated total annualized compliance cost affecting a given wood product and dividing by domestic product production in the baseline year. Import supply for each wood product is represented by the following constant elasticity supply curve:

$$Q_{Spd} = Q_{Spd0} \cdot \left(\frac{P_{pm}}{P_{pm0}}\right)^{\eta_{\mathrm{pm}}}.$$

Domestic producers allocate sales between the domestic and export markets in response to relative prices. A CET function represents the feasible allocations of sales across the two markets, with the responsiveness of the ratio of domestic to export sales governed by the elasticity of transformation parameter τ_p. Conditional on the level of domestic production, the quantity of sales allocated to the domestic and export markets can be written as:

$$QSD_p = Q_{Spd} \cdot \left(\frac{QSD_{p0}}{Q_{Spd0}}\right) \cdot \left(\frac{P_{pd}/PP_p}{P_{pd0}/PP_{p0}}\right)^{\tau_p}$$

and

$$QSX_p = Q_{Spd} \cdot \left(\frac{QSX_{p0}}{Q_{Spd0}}\right) \cdot \left(\frac{P_{px}/PP_P}{P_{px0}/PP_{p0}}\right)^{\tau_p} \cdot$$

The per-unit producer price index of domestic/exported composite bundle is given by the following CET revenue aggregation equation:

$$\mathrm{PP}_p = \mathrm{PP}_{p0} \cdot \left(\gamma_p \left(\frac{P_{pd}}{P_{pd0}}\right)^{1+\tau_\mathrm{p}} + \left(1 - \gamma_p\right)\left(\frac{P_{px}}{P_{px0}}\right)^{1+\tau_\mathrm{p}}\right)^{\left(\frac{1}{1+\tau_\mathrm{p}}\right)} \cdot$$

5.1.1.3 Demand

Total domestic demand for industrial roundwood is a derived demand based on the equilibrium supply of domestic downstream wood products (which use roundwood as an input):

$$Q_{D,RW} = \Sigma_j A_{RW,j} \cdot Q_{Sj} \cdot$$

Total domestic demand for each downstream wood product is given by a constant elasticity demand function with respect to the price of the domestic/imported wood product composite (discussed in the next paragraph):

$$QD_j = QD_{j0} \cdot \left(\frac{P_{jd}}{P_{jd0}}\right)^{\epsilon_{\mathrm{jd}}} .$$

The quantity demanded of each type of foreign export is given by:

$$X_p = X_{p0} \cdot \left(\frac{P_{pd}}{P_{pd0}}\right)^{\epsilon_{\mathrm{px}}}$$

where X_p, ϵ_{Xp}, and P_{pd} represent the relevant export demand, elasticity of demand for exports, and price of domestic output.

Domestic and imported varieties of each wood product are modeled as imperfect substitutes. Consumers have a constant elasticity of substitution (CES) between varieties and, conditional on total demand for each wood product, seek to minimize expenditure on a composite bundle of the domestic and imported varieties. In this structure, domestic demand for the domestic variety and domestic demand for the imported variety can be written as:

$$\mathrm{Q}_{Dpd} = \mathrm{Q}_{Dp} \cdot \left(\frac{Q_{Dpd0}}{Q_{Dp0}}\right) \cdot \left(\frac{P_{pd}/P_{Pc}}{P_{pd0}/P_{pc0}}\right)^{-\sigma_{\mathrm{p}}}$$

and

$$\mathrm{Q}_{Dpm} = \mathrm{Q}_{Dp} \cdot \left(\frac{Q_{Dpm0}}{Q_{Dp0}}\right) \cdot \left(\frac{P_{pm}/P_{Pc}}{P_{pm0}/P_{pc0}}\right)^{-\sigma_{\mathrm{p}}}$$

respectively. This is known as an “Armington” representation of trade. The per-unit price of domestic/imported composite bundle is given by the following CES price aggregation equation:

$$\mathrm{P}_{pc} = \mathrm{P}_{pc0} \cdot \left(\theta_p \left(\frac{P_{pd}}{P_{pd0}}\right)^{1-\sigma_{\mathrm{p}}} + \left(1 - \theta_p\right)\left(\frac{P_{pm}}{P_{pm0}}\right)^{1-\sigma_{\mathrm{p}}}\right)^{\left(\frac{1}{1-\sigma_p}\right)} .$$

5.1.1.4 Equilibrium

For a given set of regulatory cost shocks impacting domestic production of wood products, the model solves for a set of prices such that the market for the domestically produced variety, the market for the imported variety, and the market for exports are balanced; that is, domestic production allocated to domestic sales is equal to domestic demand for domestic production, import supply equals domestic demand for imports, and domestic production allocated to export sales equals demand for exports. In the notation of the model:

$$\mathrm{Q}_{Spd} = \mathrm{Q}_{Dpd} + X_p,$$

$$M_p = \mathrm{Q}_{Dpm},$$

and

$$QSX_p = \mathrm{X_p} \cdot$$

The model equations described above are written as a mixed-complementarity problem using the GAMS software package and solved. The solver computes the price and quantity changes necessary to achieve equilibrium conditional on the imposed set of regulatory cost shocks. The code repository used to enter data into the model, solve the model, and analyze results is included in the docket as an attachment to the EIA. The transition to the new equilibrium can be described as follows:

- All markets begin in the baseline equilibrium.
- Domestic wood product producers receive a compliance cost shock from regulation, which shifts the supply curve for each domestic producer.

- The model solves for the equilibrium price changes that balance market supply and demand across all markets simultaneously.

5.1.2 Baseline Data and Parameters

Running the model requires selecting a benchmark year, characterizing supply and demand in the baseline year for all relevant products, and selecting the appropriate elasticity parameters to input into the model equations. We selected 2022 as the baseline year for the analysis. Model results can be viewed as estimated deviations from observed 2022 market conditions, holding fixed all economic conditions other than the modeled compliance cost shock. The selected year aligns with the baseline dataset used for the most recent version of the Global Forest Products Model (GFPM).[77, 78]

The GFPM is a dynamic economic equilibrium model of world forestry and agricultural products that projects, among other things, the production, consumption, and prices of major forest products, including industrial roundwood, sawnwood, plywood, fiberboard, and particleboard.[79] The base year (2022) data on production, consumption, imports, exports, and prices used in the GFPM represent an average of 2021, 2022, and 2023 values from FAOSTAT.[80] Production and input-output coefficients in the GFPM are calibrated to minimize the distance

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[77] See Nepal, P., Buongiorno, J., Johnston, C. M. T., Prestemon, J., & Guo, J.-g. (2021). Global forest products trade model. In *International trade in forest products: lumber trade disputes, models and examples* (pp. 110-141). https://doi.org/10.1079/9781789248234.0006 for a history of the GFPM and a detailed description of its structure and calibration procedures. The latest version of the model data and code can be downloaded from a link here: https://buongiorno.russell.wisc.edu/gfpm/.

[78] For a book-length treatment that describes an earlier version of the model, see Buongiorno, J., Zhu, S., Zhang, D., Turner, J., & Tomberlin, D. (2003). *The Global Forest Products Model*. Academic Press. https://doi.org/10.1016/b978-0-12-141362-0.X5000-6 .

[79] Buongiorno, J. (2014). Global modelling to predict timber production and prices: the GFPM approach. *Forestry*, 88(3), 291-303. https://doi.org/10.1093/forestry/cpu047.

[80] FAO. (2021, 2022, 2023). FAOSTAT: Forestry Production and Trade. https://www.fao.org/faostat/en/#data/FO.

between estimated and reported production and between estimated input usage and input usage implied by prior technical knowledge.[81] The baseline market data for 2022 are in Table 5-2. Prices are escalated from 2022 dollars to 2024 dollars to match the dollar year used to estimate compliance costs for this final rule.[82]

The calibrated input-output coefficients (A_{ij}) from the GFPM used in the model are presented with the elasticity parameters in Table 5-3. For consistency with the baseline calibration, the domestic supply and demand elasticities for wood products used by the GFPM are used where available. The elasticity values for import supply and export demand for each wood product are calculated by scaling up the associated domestic elasticity values by 2, under the assumption that import supply and export demand are more sensitive to price changes than domestic supply and demand.

Estimates of σ_p (the Armington elasticity of substitution between domestic and imported varieties) are taken from Ahmad & Riker (2019).[83], [84] Ahmad and Riker estimate Armington elasticities at the 6-digit NAICS level for manufacturing industries, using two different cost assumptions the produce a range of values. For sawnwood, we use the midpoint of the estimates for NAICS 321113 (Sawmills). For particleboard and fiberboard, we use the midpoint of the estimates for NAICS 321219 (Reconstituted Wood Products). Veneer and plywood is split into

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[81] Nepal, P., et al. (2021). Global forest products trade model. International trade in forest products: lumber trade disputes, models and examples, 110-141. https://doi.org/10.1079/9781789248234.0006.

[82] Dollar-year adjustments are made using the Bureau of Economic Analysis (BEA) National Income and Product Accounts (NIPA) Table 1.1.9: Implicit Price Deflators for Gross Domestic Product. These data are available here: https://apps.bea.gov/iTable/?reqid=19&step=3&isuri=1&1921=survey&1903=13.

[83] Ahmad, S., & Riker, D. (2019). A Method for Estimating the Elasticity of Substitution and Import Sensitivity by Industry (2019–05–B). *Office of Economics Working Paper Series*. https://www.usitc.gov/data/pe_modeling/a_method_for_estimating_the_elasticity_of_substitution_and_import_sensitivity_by_industry.pdf.

[84] A spreadsheet containing the estimated Arming elasticity values is available here: https://www.usitc.gov/economic_models_and_data.

two NAICS (321211 and 321212) representing hardwood and softwood veneer and plywood. For plywood, we take the average of the midpoints for each NAICS weighted by 2022 import consumption value.[85] Finally, because industrial roundwood is not covered under a manufacturing NAICS, there was not an associated Armington elasticity estimate. We chose to use the maximum estimated value across all sawmill, plywood, and reconstituted wood product NAICS categories and scaled it up by a factor of 2. This method reflects a likely lower degree of product differentiation between domestic and imported varieties of raw material inputs.

For the elasticity of transformation between domestic and exported sales, we chose a value of 2.0 for each product. This choice follows the value used by EPA's computable general equilibrium model SAGE,[86] which draws the estimate from Caron & Rausch (2013).[87]

Finally, the wood products model presented in this EIA covers only a portion of domestic demand for industrial roundwood, and as a result the model only covers about 64 percent of the industrial roundwood market covered by the GFPM. To account for this, we adjust the supply elasticity to account for the fact that price changes to industrial roundwood resulting from modeled compliance cost shocks are partially absorbed by the unmodeled sectors.

To derive the appropriate adjustment, let Q_{SR} be the portion of total supply covered by the model, Q_O be the unmodeled domestic demand, and ϵ_O be the price elasticity of the unmodeled domestic demand. Then, removing product subscripts for notational simplicity, we can write:

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[85] Import consumption values were obtained by querying the USDA Forest Agricultural Service's Global Agricultural Trade System, available here: https://apps.fas.usda.gov/gats/default.aspx.

[86] Marten, A., et al. (2020). Sage Model Documentation (2.0.0). https://19january2021snapshot.epa.gov/environmental-economics/sage-model-documentation-version-200_.html.

[87] Caron, J., & Rausch, S. (2013). A Global General Equilibrium Model with US State-Level Detail for Trade and Environmental Policy Analysis -- Technical Notes (Technical Note No. 13). *Joint Program Technical Notes*. https://cs3.mit.edu/publication/15548.

$$Q_{SR} = Q_S - Q_O.$$

Taking the derivative of both sides with respect to price gives:

$$\frac{\partial Q_{SR}}{\partial P} = \frac{\partial Q_S}{\partial P} - \frac{\partial Q_O}{\partial P}.$$

Using the definition of price elasticity of supply/demand and multiplying each side by $\frac{P}{Q_{SR}}$:

$$\eta_R = \frac{\eta - (1 - \alpha) \cdot \epsilon_O}{\alpha}.$$

where α is the portion of total production covered by the model. To adjust the price elasticity of industrial roundwood used in the model, we use $\alpha = 0.64$ and $\epsilon_O = -0.04$ to reflect the proportion of the industrial roundwood market covered by the model and the quantity-weighted average of price elasticities of demand for the wood products with respect to the price of industrial roundwood. The elasticity of demand for wood product *j* with respect to the price of industrial roundwood is:

$$\frac{\partial Q_{D,j}}{\partial P_{RW,c}} = \epsilon_{jd} \cdot \frac{A_{RW,j} \cdot P_{RW,c}}{P_{jd}}$$

i.e., the elasticity of demand for product *j* multiplied by the cost-share of industrial roundwood in production of *j*.

Table 5-2 Calibrated Baseline Price and Quantity Data for Wood Products, 2022[a, b]

Wood Product	Domestic Production (million m^3)	Imports (million m^3)	Exports (million m^3)	Price (\$/m^3)
Industrial Roundwood[c]	230	1.1	13	110
Sawnwood	80	27	6.0	340
Plywood	5.3	7.9	0.98	630
Particleboard	5.4	7.2	0.62	370
Fiberboard	13	2.9	0.79	450

[a] Source: Buongiorno et al. (2022). Global Forest Products Trade Model. The latest version of the model data and code can be downloaded from a link here: https://buongiorno.russell.wisc.edu/gfpm/. [b] Numbers in this table have been rounded to two significant digits. Unrounded values from the GFPM are used for modeling. [c] This value only includes estimated industrial roundwood production used to produce sawnwood, plywood, particleboard, and fiberboard.

Table 5-3 Model Elasticity and Input-Output Parameters[a, b]

Wood Product	ϵ_{pd}	η_{pd}	σ_p	$A_{RW,j}$
Industrial Roundwood	N/A	2.10	9.1	N/A
Sawnwood	-0.5	1.31	4.05	2.07
Plywood	-0.34	1.31	4.06	2.03
Particleboard	-0.5	1.31	2.97	1.23
Fiberboard	-0.5	1.31	2.97	1.23

[a] Source: Buongiorno et al. (2022). Global Forest Products Trade Model. The latest version of the model data and code can be downloaded from a link here: https://buongiorno.russell.wisc.edu/gfpm/. [b] Source: (Ahmad & Riker, 2019). A spreadsheet containing the estimated Arming elasticity values is available here: https://www.usitc.gov/economic_models_and_data.

The compliance cost shocks (c_j) are determined for each scenario by calculating the total estimated compliance cost for each production process at each affected facility, assigning compliance costs to wood products based on whether the impacted process units are used in their manufacture – or where such information is unavailable, the relative share of each wood product in a facility's production – and dividing by total baseline domestic production in 2022. Many facilities produce multiple wood products. In these circumstances, total estimated compliance costs at a facility were assigned to products based on whether the impacted process unit associated with the compliance costs is used in the manufacture of a product. If we were unable to determine whether a process unit was used in the manufacture of a product (*e.g.*, resinated material handling units at facilities that manufacture both fiberboard and particleboard products), then we attributed compliance costs for the process unit to products based on the relative share of a facility's actual production represented by a product. These compliance cost estimates are based on existing sources. Therefore, the modeled economic impacts presented in this section can be interpreted as estimated counterfactual economic impacts in the representative year 2022, based on the estimated compliance costs of the existing source standards in this final rule applied to existing sources in that year.

The estimated per-unit compliance cost shocks for each wood product associated with this final rule and a more stringent regulatory option are shown in Table 5-4 and Table 5-5. Cost shocks are presented in 2024 dollars. The estimated compliance costs of this final rule are concentrated largely in facilities that produced sawnwood and particleboard. Particleboard receives the large per-unit compliance cost shock as a percentage of baseline price, due to the small market size relative to sawnwood. The more stringent regulatory option would establish stricter standards for atmospheric refiners and emissions of PM/HAP metals and PAH from direct wood-fired dry rotary dryers. These process units are associated with the refining and drying of wood particles or fibers, driving the increase in compliance cost shocks to the particleboard and fiberboard wood products as compared to costs under the final rule.

Table 5-4 Product-Level Compliance Cost Shocks for the Final Rule

Wood Product	Total Annualized Cost (million $2024)	$2024/m³	% of Baseline Price
Sawnwood	$23	$0.29	0.08%
Plywood	$1.5	$0.13	0.02%
Particleboard	$21	$1.17	0.30%
Fiberboard	$1.4	$0.23	0.05%

Table 5-5 Product-Level Compliance Cost Shocks for the More Stringent Option

Wood Product	Total Annualized Cost (million $2024)	$2024/m³	% of Baseline Price
Sawnwood	$23	$0.29	0.08%
Plywood	$1.5	$0.13	0.02%
Particleboard	$52	$2.9	0.74%
Fiberboard	$2.8	$0.46	0.10%

5.1.3 Uncertainties and Limitations

The modeling framework presented in this section has a variety of limitations and uncertainties. These include:

- **Structural Assumptions:** The model assumes industrial roundwood enters each downstream sector in fixed proportion. Producers do not adjust their input mix in response to input cost changes. The model also treats final demand for each downstream product as independent, meaning consumer substitution across sawnwood, plywood, fiberboard, and particleboard in response to relative price changes is not captured.
- **Elasticity Estimates:** The elasticities chosen to characterize domestic supply, domestic demand, import supply, export demand, domestic supply allocation, and import substitution play a central role in determining model outcomes. The

analysis attempts to use the best available estimates from the economic literature, but these estimates are uncertain. Results should be interpreted with that uncertainty in mind, and sensitivity analysis across plausible elasticity ranges may better reflect the potential distribution of market impacts.

- **Aggregation to National Product Markets:** The model aggregates wood products into four national product markets, treating each downstream product as a single homogeneous commodity with a single national price. Each product category encompasses a range of grades, species, and specifications, and wood products markets are regionally segmented. This aggregation is a simplifying assumption that does not capture the distribution of impacts across producing and consuming regions and the effect of substitution across product grades.
- **Partial Equilibrium Scope:** Partial equilibrium models analyze a sector, or group of related sectors, in isolation, holding conditions in the rest of the economy fixed, in contrast to general equilibrium models that capture economy-wide interactions. The partial equilibrium model employed in this EIA is appropriate for analyzing regulatory cost shocks in wood products markets, which represent a small share of the broader economy. The model does not capture feedback between the modeled wood product markets and downstream markets such as construction and housing (where wood products are intermediate inputs). It also does not account for labor market adjustments or macroeconomic impacts more generally.
- **Time Horizon and Adjustment Dynamics:** The model solves for estimated impacts in a representative year and does not capture the path of adjustment over

time. Investment responses, capacity entry and exit, and technology adoption in response to compliance requirements are inherently dynamic and can only be captured in a reduced form way by this framework.

5.1.4 Modeling Results

5.1.4.1 Price and Quantity Impacts

The estimated percentage changes to the prices and quantities caused by the final amendments are presented in Table 5-6 and Table 5-7. Analogous results for the more stringent regulatory option are in Table 5-8 and Table 5-9. In general, the model results are summarized as follows. The compliance cost shocks impacting downstream wood products raise the price of domestic production and generally reduce demand for both domestic and exported wood products. Consumers partially offset the impact of higher domestic prices by substituting imports for domestic production, which puts upward pressure on import prices.

Reduced domestic production of downstream wood products reduces demand for industrial roundwood and lowers its price. The lower price of industrial roundwood reduces the cost of producing each wood product and tends to soften the impact of the regulatory compliance cost shock. For example, suppose downstream wood product j and jj both receive a compliance cost shock. The impact of the cost shock on wood product j is smaller than if wood product jj had not received a cost shock, because reduced production of wood product jj tends to lower the price of industrial roundwood, which in turn lowers the production costs of wood product j. Finally, the lower price of industrial roundwood increases demand for its exports, but the magnitude of this effect is very small due to the small number of industrial roundwood relative to its total market size.

Table 5-6 Estimated Percentage Change in Quantity Variables Due to Final Rule

Wood Product	Domestic Production	Domestic Consumption	Imports	Exports
Industrial Roundwood	-0.034%	-0.035%	-0.044%	0.000%
Sawnwood	-0.030%	-0.002%	0.078%	-0.007%
Plywood	-0.012%	-0.003%	0.011%	-0.008%
Particleboard	-0.11%	-0.009%	0.24%	-0.026%
Fiberboard	-0.019%	-0.001%	0.035%	-0.004%

Table 5-7 Estimated Percentage Change in Price Variables Due to Final Rule

Wood Product	Domestic Price	Import Price	Export Price	Consumption Price Index	Producer Price Index
Industrial Roundwood	-0.017%	-0.017%	0.000%	-0.017%	-0.016%
Sawnwood	0.057%	0.030%	0.069%	0.050%	0.058%
Plywood	0.010%	0.004%	0.012%	0.007%	0.010%
Particleboard	0.21%	0.092%	0.26%	0.18%	0.21%
Fiberboard	0.033%	0.014%	0.041%	0.026%	0.034%

Table 5-8 Estimated Percentage Change in Quantity Variables Due to More Stringent Option

Wood Product	Domestic Production	Domestic Consumption	Imports	Exports
Industrial Roundwood	-0.049%	-0.052%	-0.065%	0.000%
Sawnwood	-0.030%	-0.002%	0.078%	-0.007%
Plywood	-0.012%	-0.003%	0.011%	-0.008%
Particleboard	-0.27%	-0.022%	0.60%	-0.063%
Fiberboard	-0.038%	-0.003%	0.071%	-0.008%

Table 5-9 Estimated Percentage Change in Price Variables Due to More Stringent Option

Wood Product	Domestic Price	Import Price	Export Price	Consumption Price Index	Producer Price Index
Industrial Roundwood	-0.026%	-0.025%	0.001%	-0.026%	-0.024%
Sawnwood	0.057%	0.030%	0.069%	0.050%	0.058%
Plywood	0.010%	0.004%	0.012%	0.007%	0.010%
Particleboard	0.523%	0.227%	0.633%	0.436%	0.527%
Fiberboard	0.065%	0.027%	0.082%	0.052%	0.067%

5.1.4.2 Economic Welfare Impacts

This section presents estimated changes to economic welfare resulting from the final amendments. The welfare impacts on consumers are summarized by consumer surplus (CS), which measures the net benefits consumers obtain by purchasing a good at a given market price. It is defined as the difference between consumers' willingness to pay (WTP) and the market price summed over all units purchased. When prices rise, CS declines because consumers pay more for units they continue to purchase and to not consume units for which their WTP falls below the market price.

For a given consumer inverse demand function $D(q)$ and price quantity pair (Q_0, P_0), CS can be written as:

$$CS = \int_0^{Q_0} [D(q) - P_0] dq \cdot$$

If $D(q)$ is the inverse of a constant elasticity demand function with price elasticity $\epsilon < 0$, this integral is equal to:

$$CS = \frac{-P_0 Q_0}{1 + \epsilon} \cdot$$

Therefore, the change in CS caused by moving from (Q_0, P_0) to (Q_1, P_1) is given by:

$$\Delta CS = \frac{-(P_1 Q_1 - P_0 Q_0)}{1 + \epsilon} \cdot$$

The estimated total changes in CS for the final rule and the more stringent regulatory option, by product and market (and summed across each individually), are presented in Table 5-10 and Table 5-11.

The welfare impacts on producers are estimated by producer surplus (*PS*). *PS* is defined as the difference between the market price of a good and the marginal cost of producing it summed over all units sold:

$$PS = \int_0^{Q_0} [P_0 - MC(q)]dq \cdot$$

The model developed for this EIA uses a reduced form constant elasticity of supply function with price elasticity η to approximate each supplier's marginal cost function. Given this, the PS integral can be written as:

$$PS = \frac{P_0 Q_0}{1+\eta},$$

and the total change in *PS* caused by moving from (Q_0, P_0) to (Q_1, P_1) is:

$$\Delta PS = \frac{P_1 Q_1 - P_0 Q_0}{1+\eta} \cdot$$

The estimated total changes in *PS* by product and market (and summed across each individually), for the final rule and the more stringent regulatory option, are presented in Table 5-12 and Table 5-13. Note that the prices used to calculate *PS* are given producer's supply prices net of any cost shocks caused by changes to input prices or compliance costs.

Table 5-10 Estimated Change in Consumer Surplus for the Final Rule (million $2024)

Wood Product	Domestic Market	Export Market	Total
Industrial Roundwood	N/A	-$0.01	-$0.01
Sawnwood	-$18	-$1.5	-$20
Plywood	-$0.90	-$0.08	-$0.98
Particleboard	-$17	-$0.62	-$18
Fiberboard	-$1.0	-$0.16	-$1.2
Total	**-$37**	**-$2.4**	**-$39**

Note: Numbers in this table have been rounded to two significant digits.

Table 5-11 Estimated Change in Consumer Surplus for the More Stringent Option (million $2024)

Wood Product	Domestic Market	Export Market	Total
Industrial Roundwood	N/A	-$0.01	-$0.01
Sawnwood	-$18	-$1.5	-$20
Plywood	-$0.90	-$0.08	-$0.98
Particleboard	-$42	-$1.5	-$43
Fiberboard	-$2.0	-$0.31	-$2.3
Total	**-$63**	**-$3.4**	**-$66**

Note: Numbers in this table have been rounded to two significant digits.

Table 5-12 Estimated Change in Producer Surplus for the Final Rule (million $2024)

Wood Product	Domestic Production	Import Production	Total
Industrial Roundwood	-$5.7	-$0.02	-$5.8
Sawnwood	-$6.6	$2.9	-$3.7
Plywood	-$0.71	$0.22	-$0.49
Particleboard	-$5.9	$2.6	-$3.3
Fiberboard	-$0.43	$0.19	-$0.24
Total	**-$19**	**$5.9**	**-$13**

Note: Numbers in this table have been rounded to two significant digits.

Table 5-13 Estimated Change in Producer Surplus for the More Stringent Option (million $2024)

Wood Product	Domestic Production	Import Production	Total
Industrial Roundwood	-$8.5	-$0.03	-$85
Sawnwood	-$6.6	$2.9	-$3.7
Plywood	-$0.71	$0.22	-$0.49
Particleboard	-$15	$6.5	-$8.1
Fiberboard	-$0.85	$0.37	-$0.47
Total	**-$31**	**$9.9**	**-$21**

Note: Numbers in this table have been rounded to two significant digits.

The estimated total change in economic welfare is calculated as the sum of the changes to CS and PS:

$$\Delta W = \Delta CS + \Delta PS \cdot$$

When domestic prices increase, some of the gains or losses to domestic producers and consumers of a product take the form of transfers between domestic and foreign actors due to changes in the prices paid for imports and exports. For example, as shown in Table 5-12, import suppliers to the domestic wood product market are estimated to gain $6.2 million in PS due to increased import prices and increased demand for imports. For this reason, it is useful to decompose the total change in welfare:

$$\Delta W = \Delta W_{Domestic} + \Delta \mathrm{W}_{\mathrm{Foreign}},$$

where $\Delta W_{Domestic}$ captures changes to CS/PS of domestic producers and consumers, while $\Delta \mathrm{W}_{\mathrm{Foreign}}$ captures changes to the CS of foreign export consumers and the PS of foreign import suppliers. Estimated changes in welfare by product and market, for both the final rule and the more stringent regulatory option, are summarized in Table 5-14 and Table 5-15.

Table 5-14 Estimated Change in Total Welfare for the Final Rule (million $2024)

Wood Product	Domestic Market	Foreign Market	Total
Industrial Roundwood	-$5.7	-$0.03	-$5.8
Sawnwood	-$25	$1.4	-$23
Plywood	-$1.6	$0.14	-$1.5
Particleboard	-$23	$2.0	-$21
Fiberboard	-$1.4	$0.03	-$1.4
Total	**-$56**	**$3.5**	**-$53**

Note: Numbers in this table have been rounded to two significant digits.

Table 5-15 Estimated Change in Total Welfare for the More Stringent Option (million $2024)

Wood Product	Domestic Market	Foreign Market	Total
Industrial Roundwood	-$8.5	-$0.04	-$8.5
Sawnwood	-$25	$1.4	-$23
Plywood	-$1.6	$0.14	-$1.5
Particleboard	-$56	$4.9	-$51
Fiberboard	-$2.9	$0.06	-$2.8
Total	**-$94**	**$6.5**	**-$88**

Note: Numbers in this table have been rounded to two significant digits.

5.2 SMALL BUSINESS ANALYSIS

The EPA performed a small entity screening analysis for impacts on all affected facilities by conducting a sales test comparing compliance costs to historic revenues at the ultimate parent company level. The use of a sales test for estimating small business impacts for a rulemaking is consistent with guidance offered by the EPA on compliance with the Regulatory Flexibility Act.[88] The sales test approach is also consistent with guidance from the U.S. Small Business

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[88] U.S. EPA. (2006). EPA's Action Development Process, Final Guidance for EPA Rulewriters: Regulatory Flexibility Act as Amended by the Small Business Regulatory Enforcement Fairness Act. https://www.epa.gov/system/files/documents/2021-07/guidance-regflexact.pdf.

Administration's (SBA) Office of Advocacy that suggests that cost as a percentage of total revenues is a metric for evaluating cost increases on small entities.[89]

For purposes of assessing the impacts of the final amendments on small entities, the EPA defined a small entity as: (1) a small business as defined by the SBA's 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.

We identified small businesses impacted by the final amendments using the inventory of affected facilities developed during the engineering cost and emissions impact analysis discussed in Chapter 3. We traced ownership of each facility listed in the inventory to the ultimate parent company using the D&B Hoovers database. We then took one of two approaches based on whether facility ownership had changed since the previous screening analysis was conducted for the May 18, 2023, proposed PCWP NESHAP amendments. If facility ownership changed or earlier revenue estimates were unavailable, then we retrieved updated employee and revenue estimates from the D&B Hoovers database.[90] If facility ownership did not change, we used 2021 data from the earlier screening analysis conducted for proposal on ultimate parent company employee and revenue estimates updated to 2024 dollars. We took this split approach to maintain consistency in data sources and due to uncertainties around data accuracy. For privately owned companies without publicly available revenue information, the D&B Hoovers database reports

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[89] SBA. (2017). A Guide for Government Agencies: How to Comply with the Regulatory Flexibility Act. https://advocacy.sba.gov/wp-content/uploads/2019/07/How-to-Comply-with-the-RFA-WEB.pdf.

[90] D&B Hoovers is a subscription-based database that can be found at https://www.dnb.com/products/marketing-sales/dnb-hoovers.html.

estimated company revenues that are generated using a proprietary model. Therefore, we were unable to confirm the accuracy of the modeled revenue estimates retrieved from the D&B Hoovers database. In contrast, the 2021 data from the screening analysis conducted for the proposal included revenues reported by affected companies during the earlier ICRs in addition to revenues from the D&B Hoovers database. We considered revenues reported directly from the affected companies during the ICRs to be more accurate than estimates of revenues retrieved from the D&B Hoovers database. Using updated 2021 revenue data additionally ensured the analysis was based on consistent data sources.

Once updated employee and revenue data were available for each ultimate parent company, we identified which parent companies were small businesses by comparing the parent company information with the small business thresholds provided by the SBA based on North American Industry Classification System (NAICS) codes. Parent companies of facilities in the PCWP source category are classified under a variety of NAICS codes. For the SBA small business size standard definition for each NAICS classification, see Table 5-16.

We identified a total of 63 ultimate parent companies and 1 Tribal government as owners of the 219 facilities, of which 18 of the ultimate parent companies were identified as small entities. Summary statistics for these ultimate parent companies are provided in Table 5-17.

Table 5-16 SBA Size Standards by NAICS Code[a]

NAICS Codes	NAICS U.S. Industry Title	Size Standard (Number of Employees)	Size Standard (Annual Revenue)
113110	Timber Tract Operations		$19,000,000
113310	Logging	500	
314110	Carpet and Rug Mills	1,500	
321113	Sawmills	550	
321114	Wood Preservation	550	
321211	Hardwood Veneer and Plywood Manufacturing	600	
321212	Softwood Veneer and Plywood Manufacturing	1,250	
321219	Reconstituted Wood Product Manufacturing	750	
321912	Cut Stock, Resawing Lumber, and Planing	500	
321918	Other Millwork (including Flooring)	500	
321999	All Other Miscellaneous Wood Product Manufacturing	500	
322130	Paperboard Mills	1,250	
325199	All Other Basic Organic Chemical Manufacturing	1,250	
326150	Urethane and Other Foam Product (except Polystyrene) Manufacturing	750	
327999	All Other Miscellaneous Nonmetallic Mineral Product Manufacturing	750	
333243	Sawmill, Woodworking, and Paper Machinery Manufacturing	550	
337110	Wood Kitchen Cabinet and Counter Top Manufacturing	750	
337122	Nonupholstered Wood Household Furniture Manufacturing	750	
423310	Lumber, Plywood, Millwork, and Wood Panel Merchant Wholesalers	150	
423990	Other Miscellaneous Durable Goods Merchant Wholesalers	100	
424720	Petroleum and Petroleum Products Merchant Wholesalers (except Bulk Stations and Terminals)	200	
441110	New Car Dealers	200	
444140	Hardware Retailers		$16,500,000
484121	General Freight Trucking, Long-Distance, Truckload		$34,000,000
523910	Miscellaneous Intermediation		$47,000,000
531110	Lessors of Residential Buildings and Dwellings		$34,000,000
551112	Offices of Other Holding Companies		$45,500,000
921150	American Indian and Alaska Native Tribal Governments [b]		

[a] The SBA small business size standards used for this analysis are from the most recent version, effective March 17, 2023, and the full table of standards can be found at: https://www.sba.gov/document/support-table-size-standards.

[b] Tribal governments are not considered small entities, according to Section 2.5.2 of the U.S. EPA's RFA guidance: https://www.epa.gov/system/files/documents/2021-07/guidance-regflexact.pdf.

Table 5-17 Summary Statistics of Potentially Affected Entities

Size	No. of Ultimate Parent Companies	No. of Facilities	Mean Revenue (million $2024)	Median Revenue (million $2024)
Small	18	22	$32	$23
Not Small	46	197	$6,806	$1,355

The results of the small business sales test for the final rule are presented below. Table 5-18 shows the distribution of average costs for ultimate parent companies by the rule, and Table 5-19 shows the distribution of cost-to-sales ratios (CSRs) for the final rule. The average compliance CSR for the 18 affected small entities is 0.56 percent and the maximum CSR for any of the affected small entities is 1.09 percent. Table 5-20 then provides the distribution of CSRs and the percentage of CSRs clearing 1 percent and 3 percent for each rule. Fewer than 20 percent of the affected small businesses are expected to experience compliance costs greater than 1 percent of their annual sales, and no small businesses are expected to experience compliance costs greater than 3 percent of their annual sales. Given the relatively low average CSR for small entities, as well as there not being a substantial percentage of small entities with a CSR greater than 1 percent and no small entities with a CSR greater than 3 percent for the final PCWP NESHAP amendments, we conclude that it is unlikely that the final changes to the PCWP source category will have a significant impact on a substantial number of small entities (SISNOSE). Therefore, we presume there is no SISNOSE for this final rule.

Table 5-18 Distribution of Estimated Compliance Costs by Entity Size, Final Rule

Size	No. of Entities	Average Annualized Cost Per Facility ($2024)	Average Annualized Cost Per Parent Company ($2024)
Small	18	$129,657	$158,469
Not Small	46	$224,926	$963,270

Table 5-19 Compliance Cost-to-Sales Ratio Distribution for Small Entities, Final Rule

Number of Small Entities	Mean CSR	Maximum CSR
18	0.56%	1.09%

Table 5-20 Compliance Cost-to-Sales Ratio Thresholds for Small Entities, Final Rule

CSR Significant Impact Thresholds	Number of Small Entities	Percent of Small Entities
CSR Greater than 1%	3	17%
CSR Greater than 3%	0	0%

5.3 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 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."[91] Even if impacts are small after long-run market adjustments to full employment, many regulatory actions have transitional effects in the short run.[92] These movements of workers in and out of jobs in response to environmental

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[91] Arrow, K. J., et al. (1996). Benefit-Cost Analysis in Environmental, Health, and Safety Regulation. American Enterprise Institute. https://aei.org/wp-content/uploads/2014/04/-benefitcost-analysis-in-environmental-health-and-safety-regulation_161535983778.pdf.

[92] OMB. (2015). 2015 Report to Congress on the Benefits and Costs of Federal Regulations and Agency Compliance with the Unfunded Mandates Reform Act. https://obamawhitehouse.archives.gov/sites/default/files/omb/inforeg/2015_cb/2015-cost-benefit-report.pdf.

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 modeling results in Section 5.1.4.1, the final requirements are likely to cause only small shifts in PCWP prices. As a result, demand for labor employed in PCWP production activities and associated industries is unlikely to see large changes. However, some industries might experience adjustments as there may be increases in compliance-related labor requirements such as labor associated with the manufacture, installation, operation, and monitoring of pollution control equipment. For this final rulemaking, we do not have the data and analysis available to quantify potential labor impacts, although we expect those impacts to be relatively small.

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