Economic Impact Analysis

Final Revisions to the National Emissions Standards for Hazardous Air Pollutants Subpart MM for the Pulp and Paper Industry

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U.S. Environmental Protection Agency
Office of Air and Radiation
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1 EXECUTIVE SUMMARY

1.1 Introduction

Section 112(f)(2) of the Clean Air Act (CAA) directs the U.S. Environmental Protection Agency (EPA) to conduct risk assessments on each source category subject to maximum achievable control technology (MACT) standards and determine if additional standards are needed to reduce residual risks from the remaining hazardous air pollutant (HAP) emissions from the category. Section 112(d)(6) of the CAA requires the EPA to review and revise the MACT standards, as necessary, taking into account developments in practices, processes, and control technologies. The section 112(f)(2) residual risk review and section 112(d)(6) technology review are to be done 8 years after promulgation. The national emissions standards for hazardous air pollutants (NESHAP) for chemical recovery combustion sources at kraft, soda, sulfite, and stand-alone semichemical pulp mills, (40 CFR part 63, subpart MM), originally promulgated on January 12, 2001, is due for a residual risk and technology review (RTR) under CAA sections 112(f)(2) and 112(d)(6). The EPA has conducted its review and proposed amendments to the NESHAP on December 30, 2016 based on this review and is finalizing the amendments.

Under the final amendments, the affected pulp and paper facilities will incur regulatory costs from the additional monitoring, testing, recordkeeping, and reporting requirements included in the amendments. This is not an economically significant rule as defined by Executive Order (EO) 12866 because the annual effects on the economy, either benefits or costs, are not estimated to potentially exceed $100 million. Therefore, the EPA is not required to develop a regulatory impact analysis (RIA) as part of this process. The EPA has prepared an economic impact analysis (EIA) for this final rule, however, and includes documentation of the methods and results. In accordance with Office of Management and Budget (OMB) Guidance M-17-21 for EO 13771, the costs for the proposed option as published in the October 2016 EIA, have been updated to 2016 dollar years for comparison with the finalized options for this analysis.

1.2 Results

The EPA estimates the regulatory program will result in very small increases in market prices and very small reductions in output of paper and paperboard products produced by the affected facilities. The regulatory program may cause negligible increases in the costs of supplying paper and paperboard products to consumers. The partial equilibrium model used in this EIA is designed to evaluate behavioral responses to changes in costs within an equilibrium setting within nationally competitive markets. The economic approach and engineering cost approach yield approximately the same estimate of the total change in surplus under the final regulations. However, the economic approach identifies important distributional impacts among stakeholders. The key results of the EIA are as follows:

- **Engineering Cost Analysis:** The year of analysis is 2020, the total costs (all in 2016$) of the final regulatory amendments are estimated to be: (1) $2.8 million in recurring costs, assumed to occur every 5 years, for periodic emissions source testing. The annualized costs are $0.60 million at a 3 percent interest rate and $0.67 million at a 7 percent interest rate; (2) $1.1 million in initial costs, which are one-time labor costs for the initial adjustments to the data acquisition systems; and (3) $0.37 million in annual costs, which are for the recordkeeping requirement associated with maintaining the proper operation of the electrostatic precipitator (ESP) automatic voltage control (AVC). In addition, the present value of the costs is $5.1 million, discounted over 5 years at 7 percent ($5.4 million discounted over 5 years at 3 percent).[1] The equivalent annualized value over 5 years is $1.2 million annually at both 7 and 3 percent discount rates.[2] We chose a 5-year time period because 5 years is the length of time between periodic emissions testing cycles.

- **Market Analysis:** The final regulatory amendments induce minimal changes in the average national price of paper and paperboard products. Paper and paperboard product prices increase less than 0.01 percent on average, while production levels decrease less than 0.01 percent on average, as a result of the rule.

- **Economic Welfare Analysis:** The economic impact analysis identifies important transitory impacts across stakeholders as paper and paperboard product markets adjust to higher production costs. The economic model shows that industries are able to pass on about $1.1 million of the final rule's costs to U.S. households in the form of higher prices. Existing U.S. producers' surplus falls by about $1.0 million, and the total U.S. economic surplus loss is $2.1 million.

- **Small Business Screening Analysis:** The EPA performed a screening analysis for impacts on small businesses by comparing estimated annualized engineering compliance costs at the facility-level to ultimate parent company sales revenues. The screening analysis found that the ratio of compliance cost to company sales revenue falls below 1 percent for the three small companies that could be affected by the final rule. Based upon this analysis, we conclude there is no significant economic impact on a substantial number of small entities (SISNOSE).

[1] The present value represents the sum of all of the costs over the 5 years discounted back to the present and assumes the total cost of the periodic emissions testing is incurred in the first year.

[2] The equivalent annualized value represents the even flow of the present value of all of the costs over 5 years.

- **Employment Impact Analysis:** The EPA estimated the annual labor required to comply with the requirements of the final rule. To do this, the EPA first estimated the labor required for the incremental monitoring, recordkeeping, and reporting, then converted this number to full-time equivalents (FTEs) by dividing by 2,080 (40 hours per week multiplied by 52 weeks). The ongoing, annual labor required for complying with the final rule is estimated at about 6 FTEs. The EPA notes that this type of FTE estimate cannot be used to make assumptions about the specific number of people involved or whether new jobs are created for new employees.

1.3 Organization of this Report

The remainder of this report details the methodology and the results of the EIA. Section 2 presents the industry profile of the paper manufacturing industry. Section 3 summarizes the regulatory options evaluated in the EIA, emissions reduction estimates, and engineering costs analysis. Section 4 presents the economic, small business, and employment impacts analyses. Section 5 lists references cited throughout the EIA.

2 INDUSTRY PROFILE

2.1 Introduction

Manufacturing of paper and paper products is a complex process that is carried out in two distinct phases: the pulping of wood and the manufacture of paper. Pulping is the conversion of fibrous wood into a "pulp" material suitable for use in paper, paperboard, and building materials. Pulping and papermaking may be integrated at the same production facility, or facilities may produce either pulp or paper alone. In addition to facilities that produce pulp and/or paper, there are numerous establishments that do not manufacture paper, but convert paper into secondary products. All of these facilities are grouped under North American Industry Classification System (NAICS) code 322. A total of 107 chemical pulp mill sources, which may or may not produce paper and/or paperboard, are currently subject to subpart MM.

In recent years, the pulp, paper and paperboard mills sector, grouped under NAICS code 3221, has experienced varied changes in the value of its shipments, with less a than 5 percent overall change over the period from 2008 through 2014, but with a decline of just over 10 percent between 2008 and 2009. Over the period from 2008 to 2014, the number of establishments in the industry declined by approximately 10 percent, and from 2008 to 2014, employment declined by just over 13 percent (Table 2-1).

Table 2-1 Key Statistics: Pulp, Paper and Paperboard Mills (NAICS 3221 – 2014$)

	2008	2009	2010	2011	2012	2013	2014
Shipments (Mil $)	$86,275	$77,112	$82,337	$85,624	$81,173	$83,163	$82,059
Payroll (Mil $)	$8,124	$7,782	$7,832	$7,904	$7,652	$7,943	$7,826
Employees	118,672	113,765	110,151	108,807	106,428	105,004	102,369
Establishments	504	492	474	470	448	446	451

Sources: U.S. Census Bureau, American Fact Finder, Annual Survey of Manufactures: General Statistics: Benchmark Statistics for Industry Groups and Industries, Tables for 2012-2014. (October 2016)

In addition, while total payroll declined slightly over this time, annual payroll per employee rose almost 12 percent from 2008 to 2014 (Table 2-2). Also, though the value of total shipments fell less than 5 percent between 2008 and 2014, the value of shipments per employee increased by about 10 percent over the time period. The number of employees per establishment fell slightly between 2008 and 2014.

Table 2-2 Industry Data: Pulp, Paper and Paperboard Mills (NAICS 3221 – 2014$)

Industry Ratios	2008	2009	2010	2011	2012	2013	2014
Total shipments (Mil $)	$86,275	$77,112	$82,337	$85,624	$81,173	$83,163	$82,059
Shipments per establishment ($000)	$171,181	$156,731	$173,707	$182,178	$181,190	$186,465	$181,948
Shipments per employee ($000)	$727	$678	$747	$787	$763	$792	$802
Shipments per $ of payroll	$10.62	$9.91	$10.51	$10.83	$10.61	$10.47	$10.49
Annual payroll per employee	$68,455	$68,407	$71,105	$72,638	$71,897	$75,643	$76,447
Employees per establishment	235	231	232	232	238	235	227

Sources: U.S. Census Bureau, American Fact Finder, Annual Survey of Manufactures: General Statistics: Benchmark Statistics for Industry Groups and Industries, Tables for 2012-2014. (June 2016)

The U.S. Census Bureau categorizes the paper manufacturing industry's facilities into two categories: pulp, paper, and paperboard mills (NAICS 3221) and converted paper product manufacturing (NAICS 3222). This action covers pulp, paper, and paperboard mills, which are further divided into the following types of facilities, as defined by the U.S. Census Bureau[3]:

- Pulp Mills (NAICS 322110): This industry comprises establishments primarily engaged in manufacturing pulp without manufacturing paper or paperboard. The pulp is made by separating the cellulose fibers from the other impurities in wood or other materials, such as used or recycled rags, linters, scrap paper, and straw.
- Paper Mills (NAICS 322121): This industry comprises establishments primarily engaged in manufacturing paper from pulp. These establishments may manufacture or purchase pulp. In addition, the establishments may convert the paper they make.
- Paperboard Mills (NAICS 322130): This industry comprises establishments primarily engaged in manufacturing paperboard from pulp. These establishments may manufacture or purchase pulp. In addition, the establishments may also convert the paperboard they make.

2.2 Supply and Demand Characteristics

Because paper is the final product, this report focuses on the supply and demand sides of paper manufacturing. Supply and demand of pulp manufacturing is more difficult to quantify. This section provides a brief overview of the supply and demand sides of the paper manufacturing industry. We include information on the economic interactions this industry has

[3] The NAICS definitions can be found at http://www.census.gov/cgi-bin/sssd/naics/naicsrch.

with other industries, identify the key goods and services used by the industry, and identify the major uses and consumers of manufactured paper products.

2.2.1 Goods and Services Used in Paper Manufacturing

In 2014, the cost of materials made up 47 percent of the value of total shipments in the paper manufacturing industry (Table 2-3). Total compensation of employees represented 13 percent of the total value in 2014. The total number of employees decreased by 4 percent between 2012 and 2014, while the value of total shipments increased by 1 percent over the same period.

Table 2-3 Costs of Goods and Services Used in the Pulp, Paper and Paperboard Mills (NAICS 3221 – 2014$)

Variable	2012	*Share*	2013	*Share*	2014	*Share*
Total Shipments (Mil $)	$81,173	*100%*	$83,163	*100%*	$82,059	*100%*
Total Compensation (Mil $)	$10,453	*13%*	$10,681	*13%*	$10,520	*13%*
Annual Payroll	$7,652	*9%*	$7,943	*10%*	$7,826	*10%*
Fringe Benefits	$2,801	*3%*	$2,738	*3%*	$2,694	*3%*
Total Number of Employees	109,428		105,004		102,369	
Average Compensation per Employee	$71,897		$75,643		$76,447	
Total Production Workers Wages (Mil $)	$5,693	*7%*	$6,044	*7%*	$5,994	*7%*
Total Production Workers	84,484		83,893		82,029	
Total Production Hours (1,000)	184,349		193,358		180,629	
Average Production Wages per Hour	$31		$33		$33	
Total Cost of Materials (Mil $)	$38,368	*47%*	$39,534	*48%*	$38,332	*47%*
Materials, Parts, Packaging	$31,626	*39%*	$32,882	*40%*	$31,382	*38%*
Purchase Electricity	$2,592	*3%*	$2,576	*3%*	$2,581	*3%*
Purchased Fuel	$3,338	*4%*	$3,477	*4%*	$3,775	*5%*
Other	$812	*1%*	$600	*1%*	$593	*1%*

Sources: U.S. Census Bureau, American Fact Finder, 2014 Annual Survey of Manufactures: General Statistics: Benchmark Statistics for Industry Groups and Industries: 2014, 2013, and 2012. (October 2016)

According to 2008 Bureau of Economic Analysis (BEA) data, the top 10 industry groups supplying inputs to the pulp, paper and paperboard mills sector accounted for about 67 percent of the total intermediate inputs (Table 2-4).[4] Forestry and logging products and pulp, paper, and

[4] Statistics prepared at the 389-industry level of disaggregation are not available after 2007. As such, we were not able to include more updated information at this level of disaggregation.

paperboard are the top two intermediate input industries of pulp, paper and paperboard goods, accounting for almost 20 percent of the value of goods and services used in the this sector.

Table 2-4 Key Goods and Services Used in the Pulp, Paper and Paperboard Mills (NAICS 3221 – millions 2007$)

Description	BEA Code	Value Sold to NAICS 3221
Forestry and logging products	1130	$5,389
Pulp, paper, and paperboard	3221	$4,155
Wholesale trade	4200	$3,916
Basic chemicals	3251	$3,734
Wood products	3210	$3,450
Management of companies and enterprises	5500	$3,154
Electric power generation, transmission, and distribution	2211	$2,690
Natural gas distribution	2212	$2,680
Truck transportation	4840	$1,428
Converted paper products	3222	$1,415
Total intermediate inputs	T005	$47,835

Source: U.S. Bureau of Economic Analysis (BEA). 2008. "2002 Benchmark Input-Output Accounts: 2002 Standard Make and Use Tables at the Summary Level." Table 2. Washington, DC: BEA.

2.2.1.1 Energy

The Department of Energy (DOE) categorizes paper manufacturing as an energy-intensive sector. Table 2-5 shows that total energy use in the three NAICS codes covered by this rule decreased by 19 percent between 1998 and 2010, and Figure 2-1 indicates that total electrical power use in the paper manufacturing industry changed sporadically between 2002 and 2004 but started to decrease after 2004.[5] In slight contrast, the 2016 Annual Energy Outlook projects that the paper manufacturing sector will experience slight positive average growth of delivered energy consumption between 2014 and 2040 (U.S. Energy Information Administration 2016). In addition, between 1998 and 2010, pulp, paper, and paperboard mills increased their

[5] The Board of Governors of the Federal Reserve discontinued the Monthly Survey of Industrial Electricity Use in November 2005. As such, we were not able to include more updated information on electric power use in the paper manufacturing sector.

sales and transfers offsite of electricity, to utility and non-utility purchasers, by about 50 percent.[6]

Table 2-5 Energy Used in Pulp, Paper and Paperboard Mills (NAICS 322110, 322121 and 322130)

Fuel Type	1998	2002	2006	2010
Net electricity[1] (million kWh)	42,026	40,779	46,361	37,397
Residual fuel oil (million bbl)	21	13	15	5
Distillate fuel oil[2] (million bbl)	1	3	2	0
Natural gas[3] (billion cu ft)	469	407	320	327
LPG and NGL[4] (million bbl)	-	-	-	0
Coal (million short tons)	10	10	9	8
Coke and breeze (million short tons)	-	-	-	0
Other[5] (trillion Btu)	1,332	1,240	1,177	1,211
Total (trillion Btu)	2,336	2,134	1,966	1,895

1 Net electricity is obtained by summing purchases, transfers in, and generation from noncombustible renewable resources, minus quantities sold and transferred out. It does not include electricity inputs from on-site cogeneration or generation from combustible fuels because that energy has already been included as generating fuel (for example, coal).
2 Distillate fuel oil includes Nos. 1, 2, and 4 fuel oils and Nos. 1, 2, and 4 diesel fuels.
3 Natural gas includes natural gas obtained from utilities, local distribution companies, and any other supplier(s), such as independent gas producers, gas brokers, marketers, and any marketing subsidiaries of utilities.
4 Examples of liquefied petroleum gases (LPG) are ethane, ethylene, propane, propylene, normal butane, butylene, ethane-propane mixtures, propane-butane mixtures, and isobutene produced at refineries or natural gas processing plants, including plants that fractionate raw natural gas liquids (NGLs).
5 Other includes net steam (the sum of purchases, generation from renewables, and net transfers), and other energy that respondents indicated was used to produce heat and power.

Source: U.S. Department of Energy, Energy Information Administration. 2010. “2010 Energy Consumption by Manufacturers—Data Tables.” Table 3.1. Washington, DC: DOE.

6 U.S. Department of Energy, Energy Information Administration. 2010. “Electricity Sales to Utility and Nonutility Purchasers.” Table 11.5. Washington, DC: DOE.

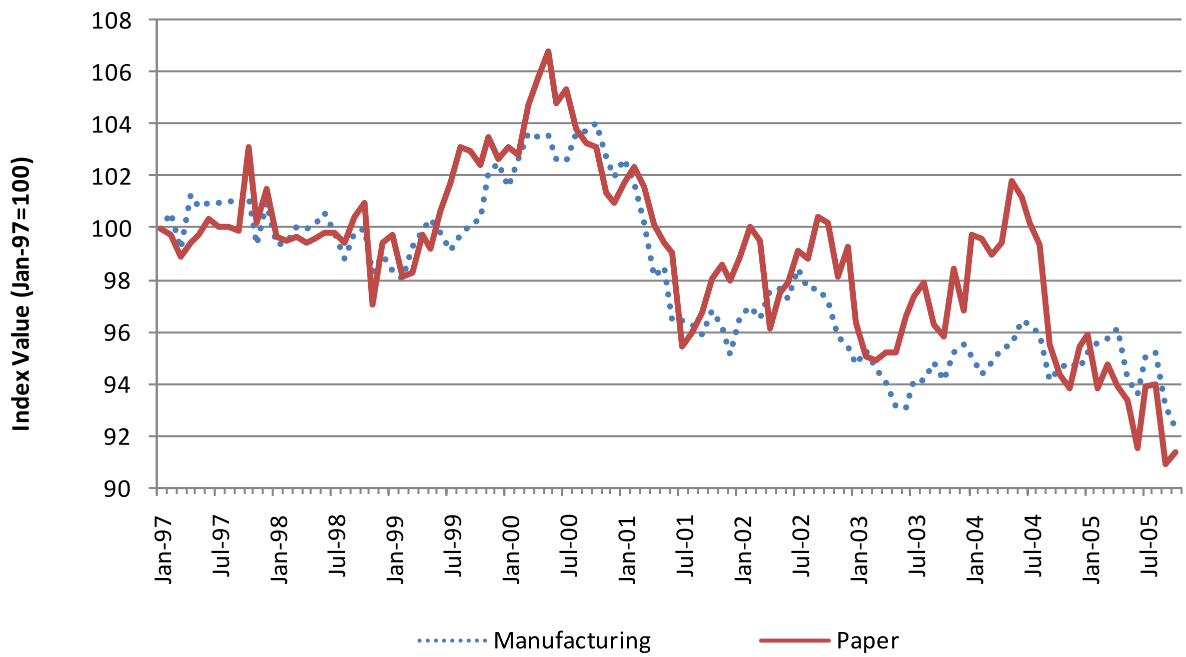

Figure 2-1 Electrical Power Use Trends in the Paper Manufacturing Industry (NAICS 322): 1997–2005

Note: The Board of Governors of the Federal Reserve discontinued the Monthly Survey of Industrial Electricity Use (FR 2009; OMB No. 7100 0057) in November 2005.

Source: Federal Reserve Board. 2009. "Industrial Production and Capacity Utilization: Electric Power Use: Manufacturing and Mining." Series ID: G17/KW/KW.GMF.S & G17/KW/KW.G322.S.

2.2.2 Uses and Consumers

A significant percentage of the products manufactured in NAICS group 322 have intermediate uses, with an average of about 85 percent of goods sold being used as inputs for other products and services. The paper manufacturing industry itself was the largest demander of paper products in 2002, accounting for almost 30 percent of the value of goods sold for intermediate use (Table 2-6). The next largest uses, about $22.5 billion worth of products manufactured in the NAICS group 322 in 2002, were purchased for use in the food, beverage, and tobacco products industry. This makes up about 15 percent of the 2002 demand for paper products. Table 2-6 also shows that the value of imports of goods and services to the paper manufacturing industry was greater, though only slightly, than the value of exports from the industry in 2002.

Table 2-6 Demand for Paper Manufacturing Industry Goods by Sector (NAICS 322 – millions 2014$)

Sector	BEA Code	Value of Goods Purchased
Paper products	322	$43,288
Food, beverage and tobacco products	311	$22,542
Printing and related support activities	323	$6,460
General state and local government services	GSLG, GSLE	$8,029
Publishing Industries, except internet (includes software)	511	$1,336
Plastics and rubber products	326	$4,707
Wholesale trade	42	$3,566
Food services and drinking places	722	$3,259
Total intermediate use	T001	$148,053
Personal consumption expenditures	F010	$26,623
Exports of goods and services	F040	$22,453
Imports of goods and services	F050	-$23,310
Total final uses (GDP)	T004	$26,639
Total commodity output	T007	$174,692

Source: U.S. Bureau of Economic Analysis (BEA). 2008. "2002 Benchmark Input-Output Accounts: 2002 Standard Make and Use Tables at the Summary Level." Table 2. Washington, DC: BEA.

2.3 Firm and Market Characteristics

This section describes geographic, production, and market data. These data provide the basis for further analysis and depict recent historical trends for production and pricing.

2.3.1 Location

As of 2012, the United States had 448 establishments in the pulp, paper, and paperboard mills sector. As Figure 2-2 illustrates, in 2012 the top 4 states in terms of pulp, paper and paperboard mills were, in order, Wisconsin, New York, Georgia and Michigan.

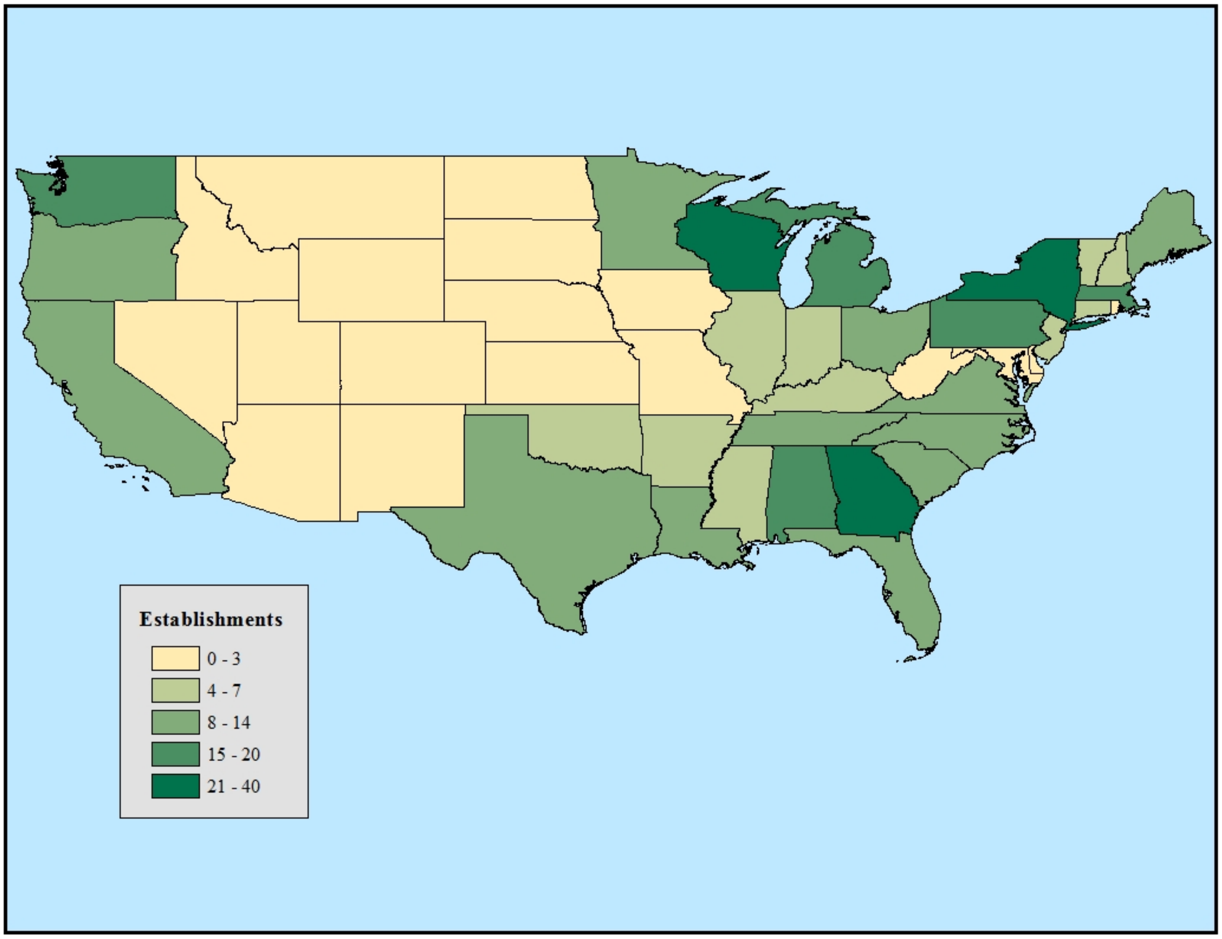

Figure 2-2 Establishment Concentration in Pulp, Paper and Paperboard Mills (NAICS 3221): 2012

Note: Alaska and Hawaii are not shown because they are in the *<50 establishments* category.

Source: U.S. Small Business Administration, Office of Advocacy, "Number of firms, establishments, employment, and payroll by firm size, state, and industry, 2012" Table ID 2012T100v1.2. (October 2016).

2.3.2 Production Capacity and Utilization

From 2002 to 2016, capacity utilization in the paper manufacturing sector experienced both a decline and recovery, similar to the total manufacturing sector, with the dip and subsequent rise mainly focused in the 2008 to 2012 time frame. However, paper manufacturing has managed to use its capacity at a consistently higher rate than the average for manufacturing industries (Figure 2-3).

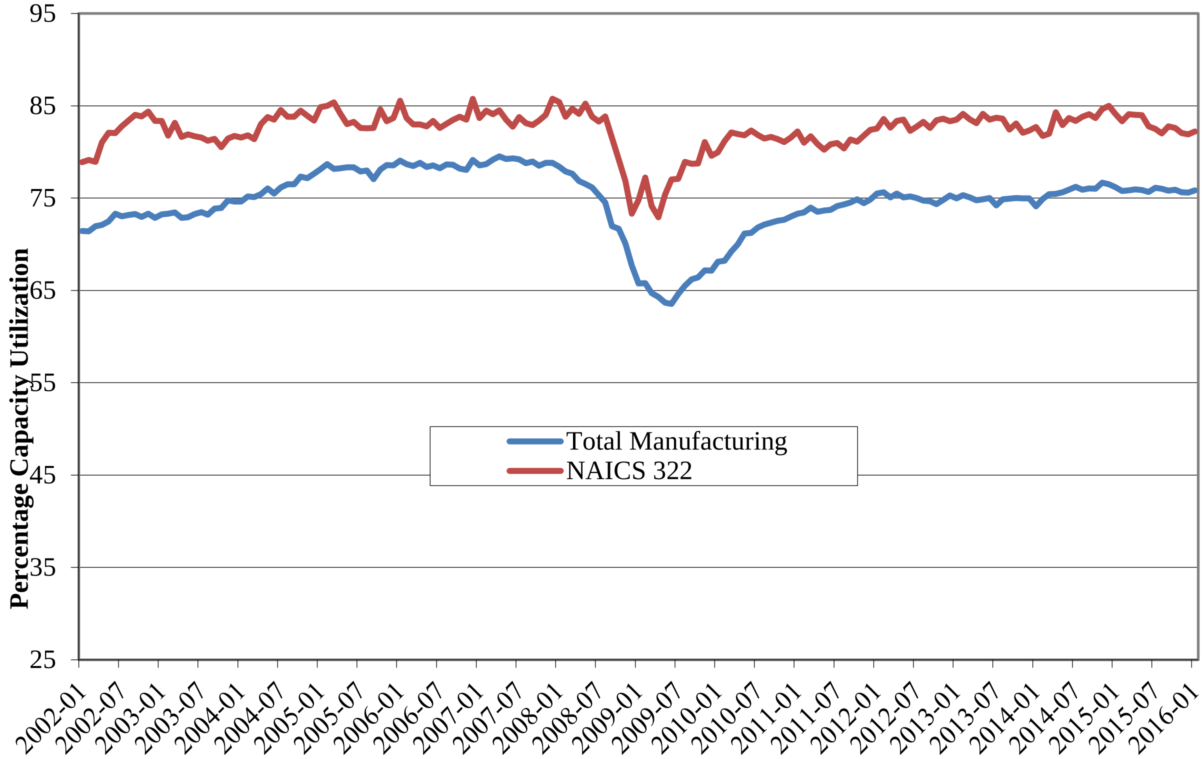

Figure 2-3 Capacity Utilization Trends in the Paper Manufacturing Industry (NAICS 322)

Source: Board of Governors of the Federal Reserve System. 2016. "Industrial Production and Capacity Utilization: Capacity Utilization." Series ID: G17/CAPUTL/CAPUTL.GMF.S & G17/CAPUTL/CAPUTL.G322.S. (June 2016).

2.3.3 Employment

Wisconsin has the largest number of employees in the pulp, paper, and paperboard mills sector, with over 11,000 reported in the 2012 census, followed by over 8,300 in Alabama, over 8,100 in Georgia, and over 5,700 in Pennsylvania. Employment numbers are not reported for some states in 2012. All of the states that do not report employment numbers report 8 or fewer establishments, and therefore, for Figure 2-4 below, we assume employment levels in the sector in those states are fewer than 2,000 employees.

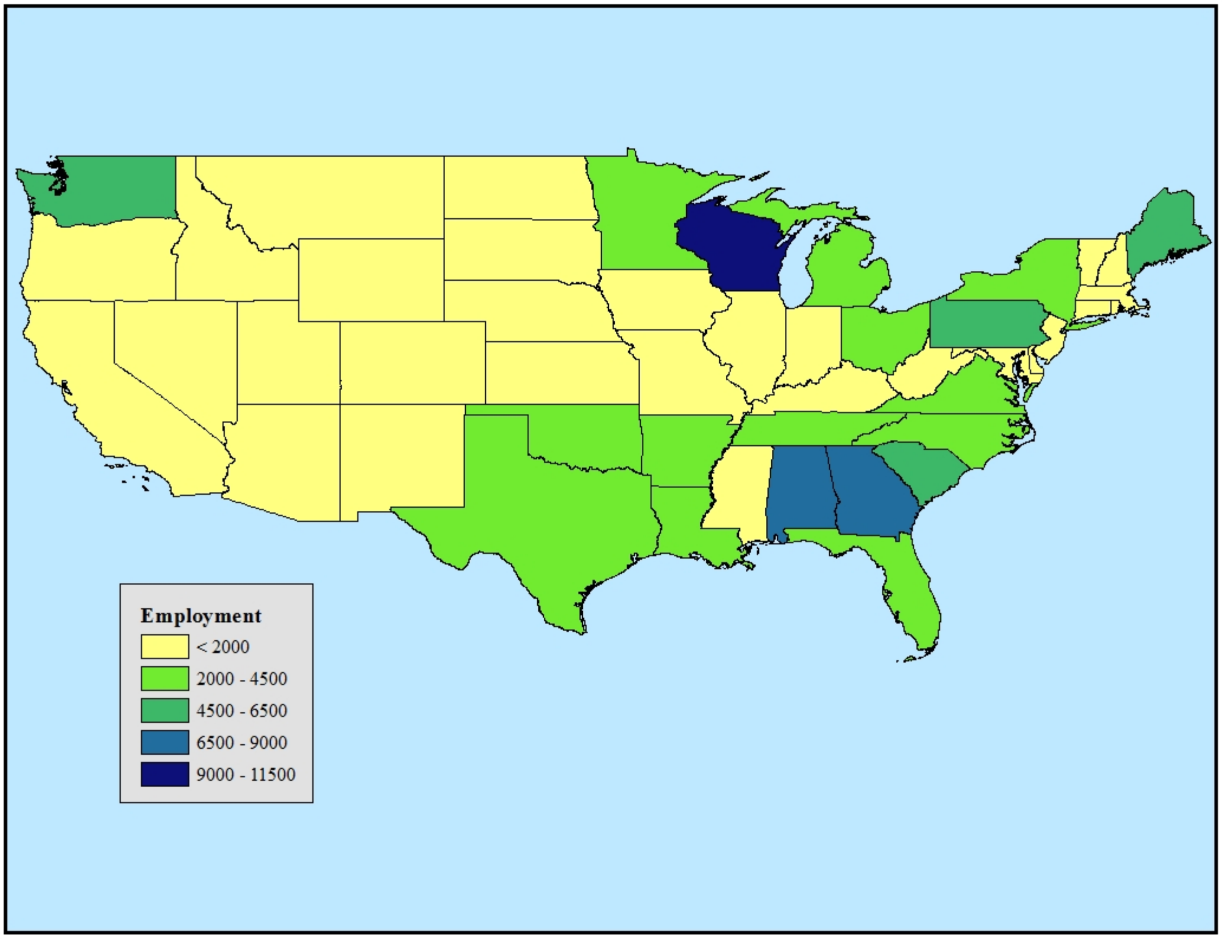

Figure 2-4 Employment Concentration in the Pulp, Paper and Paperboard Mills (NAICS 3221): 2012

Note: Alaska and Hawaii are not shown because they are in the *<50 establishments* category.

Source: U.S. Small Business Administration, Office of Advocacy, “Number of firms, establishments, employment, and payroll by firm size, state, and industry, 2012” Table ID 2012T100v1.2. (October 2016).

2.3.4 Plants and Capacity

While the manufacturing sector has been growing since 2002, the paper manufacturing sector has not experienced the same growth. The paper manufacturing sector’s capacity has declined since 2002 (Figure 2-5).

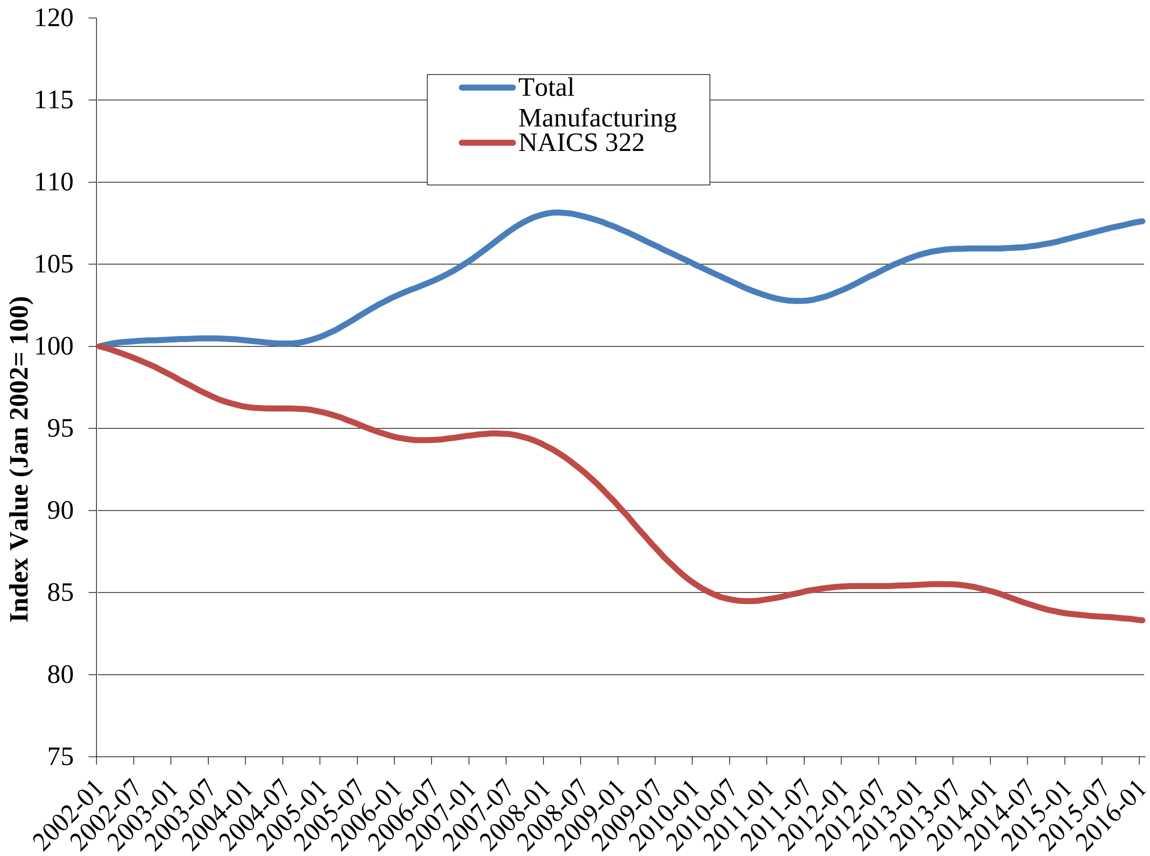

Figure 2-5 Capacity Trends in the Paper Manufacturing Industry (NAICS 322)

Source: Board of Governors of the Federal Reserve System. 2016. "Industrial Production and Capacity Utilization: Capacity Utilization." Series ID: G17/CAPUTL/CAPUTL.GMF.S & G17/CAPUTL/CAPUTL.G322.S. (June 2016).

2.3.5 Firm Characteristics

In 2015, the top 10 paper and forest product companies produced over $86 billion in revenues. The top two companies — International Paper and Kimberly-Clark Corporation — generated over $22 billion and $18 billion, respectively (Table 2-7), accounting for just under 50 percent of the revenues from the top 10 companies.

Table 2-7 Largest U.S. Pulp and Paper Companies in 2015

Company	Revenues (millions 2015$)
International Paper	22,365
Kimberly-Clark Corporation	18,591
Koch Industries	11,500
WestRock Company	9,895
Packaging Corporation of America	5,742
Smurfit-Stone Container Corporation[1]	5,574
Graphic Packaging Holding Company	4,964
Verso Corporation	3,122
Kapstone Paper and Packaging Corporation	2,789
Clearwater Paper Corporation	1,752

[1] Now operating as WestRock Company.
Source: Hoovers.com, NAICS Code 3221, accessed June 16, 2016.

2.3.6 Size Distribution

The primary criterion for categorizing a business as small is the number of employees, using definitions published by the Small Business Administration (SBA) for regulatory flexibility analyses. The number of employees in the small business cutoff varies according to six-digit NAICS codes (Table 2-8) and ranges from 750 to 1,250 employees for the facilities covered by this rule.

Table 2-8 Small Business Size Standards: Pulp, Paper and Paperboard Mills (NAICS 3221)

NAICS	NAICS Description	Employees
322110	Pulp Mills	750
322121	Paper (except Newsprint) Mills	1,250
322130	Paperboard Mills	1,250

Source: U.S. Small Business Administration (SBA). 2016. "Table of Small Business Size Standards Matched to North American Industry Classification System Codes." Effective February 26, 2016. <https://www.sba.gov/sites/default/files/files/Size_Standards_Table.pdf>.

According to the Census Bureau's Statistics of U.S. Businesses (SUSB) reports for 2012, large companies dominated revenue-generating transactions in the pulp, paper and paperboard mills sector; about 84 percent of receipts were generated by companies with 750 employees or more (Table 2-9). As can also be seen in the table, only about 24 percent of firms in 2012 had 750 or more employees.

Table 2-9 Distribution of Economic Data by Enterprise Size: Pulp, Paper and Paperboard Mills (NAICS 3221)

		Employee Size Category					
Variable	**Total**	**1 to 20[1]**	**20 to 99**	**100 to 499**	**500 to 749**	**750 to 999**	**1,000 to >5,000**
Number of Enterprises							
Firms	231	61	49	56	9	8	48
Establishments	448	61	50	68	22	15	232
Employment	108,674	354	1,799	10,466	3,852	3,347	88,531
Receipts							
Receipts (Mil $)	$81,384	$239	$833	$6,113	$2,018	$1,691	$66,481
Receipts/firm ($000)	$352,311	$3,920	$17,002	$109,158	$224,227	$211,409	$1,385,017
Receipts per establishment ($000)	$181,660	$3,920	$16,662	$89,895	$91,729	$112,751	$286,555
Receipts per employment ($)	$748.88	$675.51	$463.08	$584.07	$523.90	$505.31	$750.93

[1] Excludes SUSB employment category for zero employees. These entities only operated for a fraction of the year.

Source: U.S. Census Bureau. 2013 SUSB Annual Data Tables by Establishment Industry, Data by Enterprise Employment Size. “6-Digit NAICS Detailed Size Thresholds for 2012.”

2.3.7 Domestic Production

Similar to industry capacity rates, sector production rates for paper manufacturing decreased over the period from 2002 to 2016, with a large dip in 2008 (Figure 2-6). Though there was a very slight rebound between 2009 and 2013, the paper manufacturing sector was not able to return to its former levels of growth following the 2008 recession, and has experienced a slight downward production trend between 2013 and 2016. Dissimilar to capacity utilization rates, industrial production trends for the paper manufacturing industry are consistently lower than that of the total manufacturing industry, starting in 2003, and the gap has widened considerably over the 2003 to 2016 time frame.

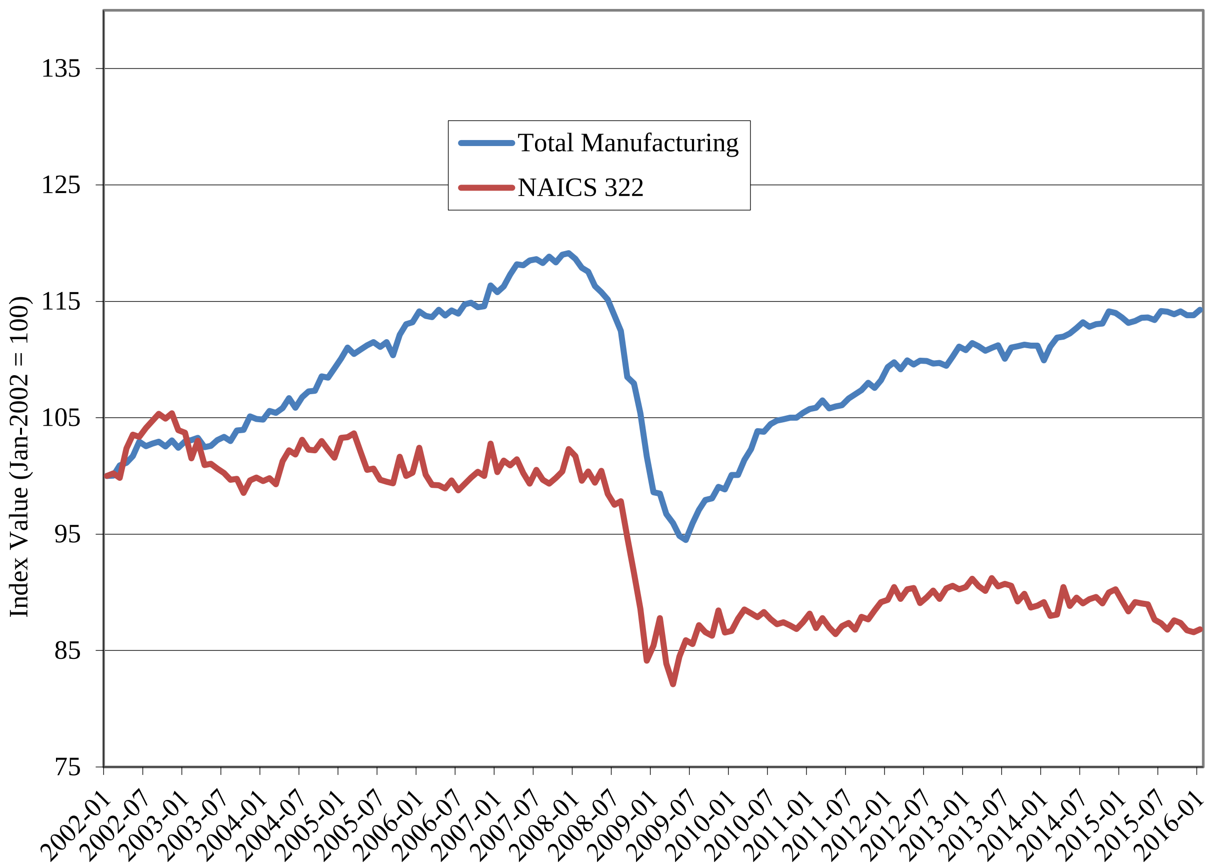

Figure 2-6 Industrial Production Trends in the Paper Manufacturing Industry (NAICS 322): 2002–2016

Source: Board of Governors of the Federal Reserve System. 2016. "Industrial Production and Capacity Utilization: Capacity Utilization." Series ID: G17/CAPUTL/CAPUTL.GMF.S & G17/CAPUTL/CAPUTL.G322.S. (June 2016).

2.3.8 International Trade

Since 2009, paper manufacturing products (NAICS 322), including pulp, paper, and paperboard products (NAICS 3221), have contributed to an increasing trade surplus in this sector (Figure 2-7). The level of surplus peaked in 2012, followed by exports of paper products falling very slightly compared to imports through 2015. However, especially compared to the rate of change pre-2012, paper product exports and imports remain fairly steady between 2013 and 2015. Pulp, paper and paperboard mill exports closely follow the trends seen in the larger paper manufacturing industry, making up over half of the total paper manufacturing exports between 2006 and 2015. The pulp, paper and paperboard mills experienced a trade surplus between 2006 and 2015, with a peak surplus in 2012 followed by a slight decline through 2015, though the majority of movement in the pulp, paper and paperboard mill international trade sector comes from changes in exports. The level of imports remains relatively low and fairly constant compared to the level of exports over time.

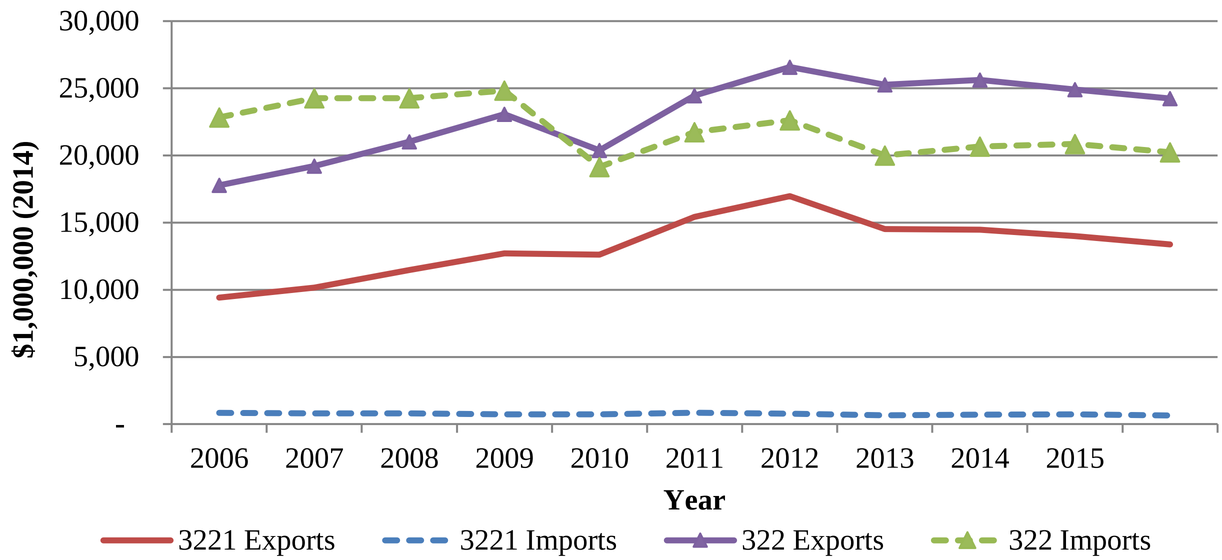

Figure 2-7 International Trade Trends in the Paper Manufacturing Industry (NAICS 322)

Note: NAICS 3221 Exports and Imports consist of exports and imports from the 6-digit NAICS codes 322110, 322121 and 322130.

Source: U.S. Census Bureau. "U.S. International Trade Statistics, Value of Exports, General Imports, and Imports for Consumption by NAICS."

2.3.9 Market Prices

Prices of goods in paper manufacturing have not been increasing (Figure 2-8). Producer price indices (PPIs) show that producer prices for paper manufacturing fell by about 19 percent between 2006 and 2015, while producer prices for all manufacturing fell by about 15 percent.

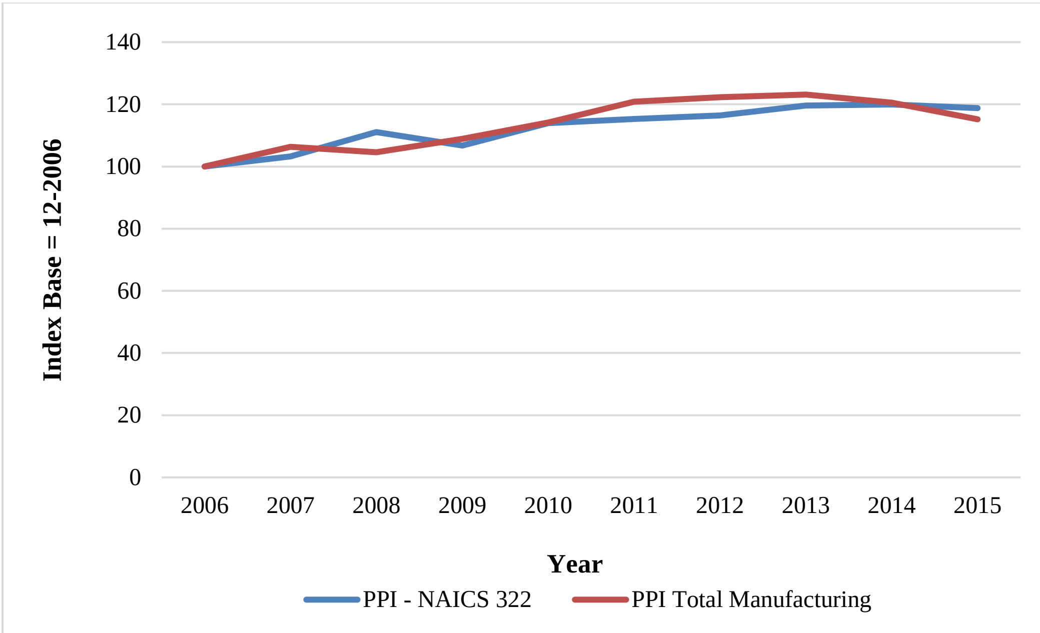

Figure 2-8 Producer Price Trends in the Paper Manufacturing Industry (NAICS 322)

Source: U.S. Bureau of Labor Statistics (BLS). 2016. "Producer Price Index." Series ID: PCU322–322– & PCUOMFG–OMFG–.

3 REGULATORY PROGRAM COST AND EMISSIONS REDUCTIONS

3.1 Introduction

The national emissions standards for hazardous air pollutants (NESHAP) for chemical recovery combustion sources at kraft, soda, sulfite, and stand-alone semichemical pulp mills (40 CFR part 63, subpart MM), originally promulgated on January 12, 2001, was due for risk and technology review under Clean Air Act sections 112(f)(2) and 112(d)(6). The EPA proposed amendments to the NESHAP on December 30, 2016, based on this risk and technology review. The EPA is finalizing amendments to the rule based on public comment and updated analyses. At the start of this review, a total of 108 chemical pulp mills' sources were subject to subpart MM; currently, there are 107 chemical pulp mills' sources subject to subpart MM.[7] The emissions units covered under subpart MM include recovery furnaces, smelt dissolving tanks (SDTs), and lime kilns at kraft and soda pulp mills and chemical recovery combustion units at sulfite pulp mills and stand-alone semichemical pulp mills.

Under the final amendments, the affected pulp and paper facilities will incur regulatory costs from the additional monitoring, recordkeeping, and reporting requirements and the requirement for periodic emissions source testing once every 5 years. This section presents the regulatory options evaluated in the EIA, estimated emissions reductions, and the engineering cost analysis associated with the regulatory options.

3.2 Engineering Costs and Emissions Reductions for Regulatory Options

In this EIA, we analyze regulatory options associated with opacity limits for kraft/soda recovery furnaces and lime kilns subject to subpart MM, as well as additional monitoring, testing, recordkeeping, and reporting requirements. The EPA is not making any changes to the recovery furnace gaseous organic HAP limits because the regulatory options associated with gaseous organic HAP limits for kraft/soda recovery furnaces were determined to be cost prohibitive prior to proposal of the December 2016 amendments.[8] No developments in practices

[7] One mill shut down between the publications of the proposed rule and the final rule.
[8] See *Economic Impact Analysis for Proposed Revisions to the National Emissions Standards for Hazardous Air Pollutants, Subpart MM, for the Pulp and Paper Industry.* October 2016.

or processes were identified or considered as rule changes for SDTs, semichemical combustion units, or sulfite combustion units as a result of this review.

3.2.1 Gaseous Organic HAP Standard Regulatory Options for Kraft/Soda Furnaces

Currently, there is no gaseous organic HAP limit for existing sources, and a limit of 0.025 pounds of gaseous organic HAP per ton of black liquor solids fired for new sources. The technology basis for the current new source limit is use of an NDCE recovery furnace with a dry ESP system. In the final rulemaking, EPA is not making any changes to the existing or new source limits. As such, there are no estimated costs or emissions reductions.

At proposal, two additional options for revising the gaseous organic HAP limits for recovery furnaces were assessed: (1) developing a single limit for existing recovery furnaces (expected to be based on an NDCE recovery furnace with a dry ESP system, which would necessitate low-odor conversion or replacement of existing DCE recovery furnaces) with no change for new recovery furnaces, and (2) developing separate limits for existing DCE and NDCE recovery furnaces (expected to result in low-odor conversion of DCE recovery furnaces unable to meet the limit, and wet-to-dry ESP conversions for NDCE recovery furnaces with wet-bottom ESPs) with no change for new recovery furnaces. These two options were determined to be cost prohibitive.

3.2.2 Opacity Regulatory Options for Kraft/Soda Recovery Furnaces and Lime Kilns

The current opacity monitoring requirements for recovery furnaces have two parts: (1) an opacity limit of 35 percent for existing sources and 20 percent for new sources, and (2) a monitoring allowance of 6 percent of quarterly operating time for both existing and new sources. The current opacity monitoring requirements for lime kilns for both existing and new sources include an opacity limit of 20 percent and a monitoring allowance of 6 percent of quarterly operating time. Below is a summary of the options for revising the current opacity monitoring requirements at proposal and for the final amendments.

Option 1 (Option at Proposal): For recovery furnaces, reduce the opacity limit for existing sources to 20 percent and retain the 20 percent opacity limit for new sources, and reduce the monitoring allowance to 2 percent of semiannual operating time for existing and new sources. For lime kilns, retain the 20 percent opacity limit for existing and new sources and reduce the monitoring allowance to 1 percent of semiannual operating time for existing and new sources.

Option 2 (Option Being Finalized): For recovery furnaces, retain the 35 percent opacity limit for existing sources and the 20 percent opacity limit for new sources, and reduce the monitoring allowance to 2 percent of semiannual operating time for existing and new sources. For lime kilns, retain the 20 percent opacity limit for existing and new sources and reduce the monitoring allowance to 3 percent of semiannual operating time for existing and new sources.

At proposal, the EPA assumed that recovery furnaces and ESP-controlled lime kilns that did not meet the regulatory options assessed would require (1) ESP maintenance and testing to improve opacity performance, or (2) an ESP upgrade. The Agency used opacity monitoring data for recovery furnaces and lime kilns to determine the affected emissions units. The monitoring data were documented in the June 14, 2016 technical memorandum entitled *Review of Continuous Opacity Monitoring System Data from the Pulp and Paper ICR Responses for Subpart MM Sources*, which is located in Docket ID No. EPA-HQ-OAR-2014-0741 (U.S. Environmental Protection Agency 2016). The ESP maintenance and testing costs were applied for recovery furnaces and lime kilns already achieving a particulate matter (PM) performance level associated with an upgraded ESP. Otherwise, units were assumed to require an ESP upgrade to meet the opacity regulatory options.

Since proposal, EPA updated and re-estimated ESP upgrade costs using a combination of industry and EPA cost information (BE&K 2001, U.S. Environmental Protection Agency 2002) and scaled the estimates to 2016 dollars. The EPA estimated recovery furnace ESP upgrade costs for adding two parallel fields to an existing ESP. For lime kilns, the costs were based on adding one field to the existing ESP. The capital and annualized cost equations for the recovery furnace and lime kiln ESP upgrades are documented in the August 19, 2016 technical memorandum entitled *Costs/Impacts of the Subpart MM Residual Risk and Technology Review*, which is located in Docket ID No. EPA-HQ-OAR-2014-0741 (RTI 2016).

After proposal, the EPA received public comments questioning the costs of proposed changes to the opacity requirements, which are presented in the comment-response document for subpart MM entitled *NESHAP for Chemical Recovery Combustion Sources at Kraft, Soda, Sulfite, and Stand-Alone Semichemical Pulp Mills (40 CFR Part 63, Subpart MM) RTR, Final Amendments: Response to Public Comments on December 30, 2016 Proposal* (U.S. Environmental Protection Agency 2017a). In response to these comments, the EPA revised the cost estimates as documented in the technical memorandum entitled *Revised Costs/Impacts of the*

Subpart MM Residual Risk and Technology Review for Promulgation (RTI 2017). In this analysis, the EPA estimated costs that are significantly higher than estimated at proposal, and the revised costs are presented in Table 3-1 below.

Considering the results of analyses performed for the final action, the EPA is not finalizing the recovery furnace and lime kiln opacity requirements as proposed. Instead, for recovery furnaces, the EPA is retaining the 35 percent opacity limit for existing sources and the 20 percent opacity limit for new sources and changing the monitoring allowance from 6 percent of quarterly operating time to 2 percent of semiannual operating time. For lime kilns, the EPA is retaining the 20 percent opacity limit for existing and new sources and changing the monitoring allowance from 6 percent of quarterly operating time to 3 percent of semiannual operating time. The monitoring data, documented in the May 25, 2017 technical memorandum entitled *Addendum to the Review of Continuous Opacity Monitoring System Data from the Pulp and Paper ICR Responses for Subpart MM Sources*, show that all of the recovery furnaces and lime kilns can meet the limits (U.S. Environmental Protection Agency 2017b). As such, there are no estimated costs or emissions reductions.

Table 3-1 Nationwide Cost Impacts and Emissions Reductions of Opacity Monitoring Limit Regulatory Options for Recovery Furnaces and Lime Kilns (2016$)

Options – Recovery Furnaces	Number of Mills Impacted	Capital Costs, Million$	Annualized Costs, Million $/yr[1]	Baseline HAP from Impacted Units, tpy	Incremental HAP Emissions Reductions, tpy	Cost Effectiveness, $/ton
Option 1 (Option at Proposal) -- Reduce Opacity Limit and Monitoring Allowance, Semiannual Reporting. 20% opacity, 2% monitoring allowance, semiannual reporting	11	$124	$18, $21	1,665 (PM) 0.50 (HAP metals)	235 (PM) 0.07 (HAP metals)	$77,000-$91,400 (PM) $257 - $305 million (HAP metals[2])
Option 2 (Option Being Finalized) -- Maintain Opacity Limit, Reduce Monitoring Allowance, Semiannual Reporting 35% opacity for existing, 20% opacity for new, 2% monitoring allowance, semiannual reporting	0	$0	$0	0	0	NA

Options – Lime Kilns	Number of Mills Impacted	Capital Costs, Million$	Annualized Costs, Million $/yr	Baseline HAP from Impacted Units, tpy	Incremental HAP Emissions Reductions, tpy	Cost Effectiveness, $/ton
Option 1 (Option at Proposal) -- Maintain Opacity Limit, Reduce Monitoring Allowance, Semiannual Reporting. 20% opacity, 1% monitoring allowance, semiannual reporting	2	$4.8	$0.73, $0.87	11 (PM) 0.05 (HAP metals)	0	NA
Option 2 (Option Being Finalized) -- Maintain Opacity Limit, Reduce Monitoring Allowance, Semiannual Reporting. 20% opacity, 3% monitoring allowance, semiannual reporting	0	$0	$0	0	0	NA

[1] The values presented in this column are calculated using 3% and 7% interest rates.

[2] As documented in Table B-6 of the technical memorandum entitled *Revised Costs/Impacts of the Subpart MM Residual Risk and Technology Review for Promulgation*, less than 0.5% of the PM emissions are comprised of HAP metals (0.03% for recovery furnaces and 0.48% for lime kilns). Thus, the cost effectiveness specifically for HAP metals is orders of magnitude greater than that shown for PM.

3.2.3 ESP Parameter Monitoring for Recovery Furnaces and Lime Kilns

The proposed revisions to subpart MM would have required monitoring of ESP secondary voltage and secondary current (or, alternatively, total secondary power) to indicate ongoing compliance at all times, including times when the opacity monitoring allowance is used. In response to comments received after proposal, the EPA revised the cost estimates, which are significantly higher than what was estimated at proposal (RTI 2017). The revised costs are presented in Table 3-2 below.

Instead of ESP parameter monitoring, some commenters suggested that the EPA should require proper operation of the ESP AVC (U.S. Environmental Protection Agency 2017a). Given the higher cost for ESP parameter monitoring and the availability of an operating practice that facilities are currently using, the EPA is not finalizing the proposed ESP parameter monitoring requirement, but is instead requiring proper operation of the ESP AVC. Because existing ESPs already have AVC, there are no estimated equipment costs. There will be recordkeeping costs, which are included in the recordkeeping cost estimates in Section 3.2.5.

Table 3-2 Nationwide Cost Impacts of ESP Parameter Monitoring for Recovery Furnaces and Lime Kilns (2016$)

Option	Number of Mills Impacted	Capital Costs, Million$	Annualized Costs, Million$/yr[2]	Baseline HAP from Impacted Units, tpy[7]	Incremental HAP Emissions Reductions, tpy	Cost Effectiveness $/ton
Option 1 (Option at Proposal) Add ESP Parameter Monitoring	96[1]	$16	$3.6, $4.0	NA	NA	NA
Option 2 (Option Being Finalized) Require Proper Operation of ESP AVC	96[1]	$0	$0	NA	NA	NA

[1] This represents all mills with ESP-controlled recovery furnaces and lime kilns.
[2] The values presented in this column are calculated using 3% and 7% interest rates.

3.2.4 Periodic Emissions Testing for all Subpart MM Units

The final revisions include a requirement for periodic emissions source testing once every 5 years. To estimate an annualized cost for emissions testing, the EPA treated emissions compliance testing costs as capital, assuming mills would contract with a testing company to perform the testing. The costs were annualized at 3 and 7 percent interest rates over the 5-year testing period, assuming that mills would obtain a 5-year loan to finance the testing. The nationwide periodic emissions source testing costs include a recurring cost every 5 years of $2.8 million dollars. The nationwide periodic emissions source testing costs are estimated to be approximately $0.60 million annually at a 3 percent interest rate and $0.67 million annually at a 7 percent interest rate (2016$). Table 3-3 presents estimated costs for individual emissions tests. The testing costs include costs associated with entering information into the EPA's Electronic Reporting Tool (ERT) for the test methods currently supported in the ERT (Method 5, Method 25A, and Method 308).

Table 3-3 Emissions Testing Costs by Mill Process (2016$)

Process Unit Type	Subpart MM Standard	Test Method (surrogate pollutant)	Capital Cost per Test Every 5 Years	Annualized Capital Cost Per Test, $/year[1]	Annualized Capital Cost Per Test, $/year[2]
Kraft and soda recovery furnaces, lime kilns, and SDTs	Metal HAP	Method 5 (PM)	$10,000	$2,180	$2,440
Sulfite combustion units	Metal HAP	Method 5 (PM)	$10,000	$2,180	$2,440
Kraft and soda recovery furnaces (new sources)	Gaseous organic HAP	Method 308 (Methanol)	$14,000	$3,060	$3,410
Semichemical combustion units	Gaseous organic HAP	Method 25A (THC)	$14,000	$3,060	$3,410

[1]Annualized over the 5-year testing period at 3 percent interest (capital recovery factor=0.218)
[2]Annualized over the 5-year testing period at 7 percent interest (capital recovery factor=0.244)

3.2.5 Recordkeeping and Reporting

The incremental recordkeeping and reporting costs associated with the final changes to subpart MM include (1) one-time costs to adjust existing data acquisition systems (DAS) at existing sources to include startup and shutdown periods and the revised opacity monitoring allowances, and to provide output for electronic reporting, and (2) annual costs for recordkeeping associated with the requirement to maintain proper operation of the ESP AVC. The nationwide incremental recordkeeping and reporting costs are estimated to be $1.1 million in initial (one-time) costs to adjust existing data acquisition systems and $0.37 million annually (2016$) for recordkeeping associated with the ESP AVC requirement (RTI 2017).

3.3 Summary of Costs and Emissions Reductions from Final Amendments

For the final amendments, the year of analysis is 2020 and the nationwide costs are associated with the periodic emissions testing and recordkeeping and reporting requirements. Tables 3-4 and 3-5, below, summarize the cost impacts of these final amendments to subpart MM. The total costs (all in 2016$) are comprised of:

- $2.8 million in recurring costs associated with periodic emissions source testing. These recurring costs are assumed to occur every 5 years. To estimate an annualized cost for the emissions source testing, the EPA treated emissions compliance testing costs as capital costs, assuming mills would contract with a testing company to perform the testing. The annualized costs are $0.60 million at a 3 percent interest rate and $0.67 million at a 7 percent interest rate.

- $1.1 million in initial costs, which are one-time labor costs for the initial adjustments to the data acquisition systems.

- $0.37 million in annual costs, which are for the recordkeeping requirements associated with the ESP AVC requirement.

Table 3-4 Nationwide Costs and Emissions Reductions for Final Amendments to Subpart MM for Opacity Monitoring Limits, Recovery Furnaces and Lime Kilns (2016$)

	Number of Mills Impacted	Capital Costs, Million$	Annualized Costs, Million $/yr[1]	Baseline HAP from Impacted Units, tpy	Incremental HAP Emissions Reductions, tpy	Cost Effectiveness, $/ton
Options – Recovery Furnaces						
<u>Option 1 (Option at Proposal)</u> -- Reduce Opacity Limit and Monitoring Allowance, Semiannual Reporting. 20% opacity, 2% monitoring allowance, semiannual reporting	11	$124	$18, $21	1,665 (PM) 0.50 (HAP metals)	235 (PM) 0.07 (HAP metals)	$77,000 - $91,400 (PM) $257 - $305 million (HAP metals[2])
Option 2 (Option Being Finalized) -- Maintain Opacity Limit, Reduce Monitoring Allowance, Semiannual Reporting. 35% opacity for existing, 20% opacity for new, 2% monitoring allowance, semiannual reporting	0	$0	$0	0	0	NA
Options – Lime Kilns						
Option 1 (Option at Proposal) -- Maintain Opacity Limit, Reduce Monitoring Allowance, Semiannual Reporting. 20% opacity, 1% monitoring allowance, semiannual reporting	2	$4.8	$0.73, $0.87	11 (PM) 0.05 (HAP metals)	0	NA

	Number of Mills Impacted	Capital Costs, Million$	Annualized Costs, Million $/yr[1]	Baseline HAP from Impacted Units, tpy	Incremental HAP Emissions Reductions, tpy	Cost Effective ness, $/ton
Option 2 (Option Being Finalized) -- Maintain Opacity Limit, Reduce Monitoring Allowance, Semiannual Reporting. 20% opacity, 3% monitoring allowance, semiannual reporting	0	$0	$0	0	0	NA
TOTAL	**0**	**$0**	**$0**	**---**	**---**	**---**

[1] The values presented in this column are calculated using 3% and 7% interest rates.
[2] As documented in Table B-6 of the technical memorandum entitled "*Revised Costs/Impacts of the Subpart MM Residual Risk and Technology Review for Promulgation*." less than 0.5% of the PM emissions are comprised of HAP metals (0.03% for recovery furnaces or 0.48% for lime kilns). Thus, the cost effectiveness specifically for HAP metals is orders of magnitude greater than that shown for PM.

Table 3-5 Nationwide Costs for Final Amendments to Subpart MM for Periodic Testing and Recordkeeping and Reporting Requirements (2016$)

	Number of Mills Impacted	Recurring Costs, Million$	Annualized Costs, Million $/yr[1]	Initial Costs, Million$	Annual Costs, Million $/yr
Proper Operation of ESP AVC (equipment cost)	96[2]	---	$0	---	---
Periodic Emissions Testing (recurring costs - once every 5 years)[3]	107	$2.8	$0.60, $0.67	---	---
Incremental Recordkeeping and Reporting					
Initial DAS Adjustments (initial costs -- one-time)[4]	107	---	---	$1.1	---
ESP AVC Reporting (annual costs)[5]	96[2]	---	---	---	$0.37
TOTAL	**107**	**$2.8**	**$0.60, $0.67**	**$1.1**	**$0.37**

[1] The values presented in this column are calculated using 3% and 7% interest rates.
[2] This represents all mills with ESP-controlled recovery furnaces and lime kilns.
[3] The recurring costs are assumed to occur every 5 years and are for periodic emissions source testing. To estimate an annualized cost for the emissions source testing, the EPA treated emissions compliance testing costs as capital costs assuming mills will contract with a testing company to perform the testing. These costs were annualized at 3 and 7 percent interest rates over the 5-year testing period.
[4] The initial costs are one-time labor costs for the initial adjustments to the data acquisition systems.
[5] The annual costs are the costs for recordkeeping for ESP automatic voltage control or power management systems.

In addition, the present value of the costs is $5.1 million, discounted over 5 years at 7 percent ($5.4 million discounted over 5 years at 3 percent). The present value represents the sum of all of the costs over the 5 years discounted back to the present and assumes the total cost of the periodic emissions testing is incurred in the first year. We chose a 5-year time period because 5 years is the length of time between periodic emissions testing cycles. The equivalent annualized value over 5 years is $1.2 million annually at both 7 and a 3 percent discount rates. The equivalent annualized value represents the even flow of the present value of all of the costs over 5 years. Note that the annualized costs presented in Table 3-5 include the recurring testing cost only, and the equivalent annualized value presented in Table 3-6 reflects the total cost (*e.g.*, recurring costs, initial costs, and annual costs). Table 3-6 below summarizes these results.

Table 3-6 Nationwide Costs for Final Amendments to Subpart MM, Net Present Value and Equivalent Annualized Value (2016$)

	Undiscounted Costs			Total Discounted Costs	
Year	**Recurring and Initial Costs (Million $)**	**Annual Costs (Million $/year)**	**Total Costs (Million $)**	**7 Percent (Million $)**	**3 Percent (Million $)**
1	3.8	0.37	4.2	3.9	4.1
2	--	0.37	0.37	0.32	0.34
3	--	0.37	0.37	0.30	0.33
4	--	0.37	0.37	0.28	0.33
5	--	0.37	0.37	0.26	0.32
Present Value	--	--	--	5.1	5.4
Equivalent Annualized Value	--	--	--	1.2	1.2

3.4 Secondary Environmental and Energy Impacts

Table 3-7 presents the energy and secondary emissions impacts of the regulatory options. The energy impacts include increased electricity use associated with changes in the emissions control technology (*e.g.*, ESP upgrades). Secondary emissions include the emissions (*e.g.*, PM, fine PM ($PM_{2.5}$), carbon monoxide (CO), nitrogen oxides (NOx), sulfur dioxide (SO_2), carbon dioxide equivalents (CO_2e), and mercury (Hg)) that result from the generation of this electricity by offsite utilities.[9]

[9] CO_2e is the sum of the emissions for CO_2, methane (CH_4), and nitrous oxide (N_2O), expressed in terms of CO_2 using their respective global warming potentials—1 for CO_2, 25 for CH_4, and 298 for N_2O.

Table 3-7 Secondary Environmental and Energy Impacts of Recovery Furnace Opacity Regulatory Options (MMBtu/year and tons per year)

Regulatory Option	Number of Impacted Mills	Energy Impacts, (MMBtu/ year)	Tons/year					
			PM and $PM_{2.5}$	CO	NOx	SO_2	CO_2e	Hg
Recovery Furnaces, Option 1 (Option at Proposal) -- Reduce Opacity Limit and Monitoring Allowance, Semiannual Reporting. 20% opacity, 2% monitoring allowance, semiannual reporting	11	294,101	1.4 0.5	4.7	21	53	15,000	0.2
Recovery Furnaces, Option 2 (Option Being Finalized) -- Maintain Opacity Limit, Reduce Monitoring Allowance, Semiannual Reporting. 35% opacity for existing, 20% opacity for new, 2% monitoring allowance, semiannual reporting	0	0	0	0	0	0	0	0
Lime Kilns, Option 1 (Option at Proposal) – Maintain Opacity Limit, Reduce Monitoring Allowance, Semiannual Reporting. 20% opacity, 1% monitoring allowance, semiannual reporting	2	18,435	0.09 0.03	0.3	1.3	3.3	940	0.01
Lime Kilns, Option 2 (Option Being Finalized) -- Maintain Opacity Limit, Reduce Monitoring Allowance, Semiannual Reporting. 20% opacity, 3% monitoring allowance, semiannual reporting	0	0	0	0	0	0	0	0

4 ECONOMIC IMPACT ANALYSIS

4.1 Introduction

The economic impact analysis is designed to inform decision makers about the potential economic consequences of a regulatory action. For the final rule, the EPA performed a partial-equilibrium analysis of national pulp and paper product markets to estimate potential paper product market and consumer and producer welfare impacts of the regulatory alternatives. This section also presents the analysis used to support the conclusion that the EPA anticipates there will be no Significant Economic Impact on a Substantial Number of Small Entities (SISNOSE) arising from the final NESHAP amendments. The section concludes with estimates of the initial and annual labor required to comply with the regulatory alternatives.

4.2 Market Analysis

The EPA performed a series of single-market, partial-equilibrium analyses of national pulp and paper product markets to measure the economic consequences of the final regulatory amendments. With the basic conceptual model described below, we estimated how the regulatory program affects prices and quantities for 10 paper and paperboard products that, aggregated, constitute the production of the industry. We also conducted an economic welfare analysis that estimates the consumer and producer surplus changes associated with the final regulatory program. The welfare analysis identifies how the regulatory costs are distributed across two broad classes of stakeholders: consumers and producers.

4.2.1 Market Analysis Methods

The model uses a common analytic expression to analyze supply and demand in a single market (Berck and Hoffmann 2002; Fullerton and Metcalf 2002) and follows the EPA guidelines for conducting an economic impact analysis (U.S. Environmental Protection Agency 2010). We illustrate our approach for estimating market-level impacts using a simple, single partial-equilibrium model. The method involves specifying a set of nonlinear supply and demand relationships for the affected market, simplifying the equations by transforming them into a set of linear equations, and then solving the equilibrium system of equations (see Fullerton and Metcalfe (2002) for an example).

First, we consider the formal definition of the elasticity of supply, q_s, with respect to changes in own price, *p*, where ε_s represents the market elasticity of supply:

$$\varepsilon_s = \frac{dq_s/q_s}{dp/p}. \tag{4.1}$$

Next, we can use "hat" notation to transform Eq. 4.1 to proportional changes and rearrange terms:

$$\hat{q}_s = \varepsilon_s \hat{p}, \tag{4.1a}$$

where $\hat{q}_s$ equals the percentage change in the quantity of market supply, and $\hat{p}$ equals the percentage change in market price. As Fullerton and Metcalfe (2002) note, we have taken the elasticity definition and turned it into a linear behavioral equation for the market we are analyzing.

To introduce the direct impact of the regulatory program, we assume the per-unit cost associated with the regulatory program, *c*, leads to a proportional shift in the marginal cost of production ($\widehat{mc}$). The per-unit costs are estimated by dividing the total estimated annualized engineering costs accruing to producers within a given product market by the baseline national production in that market. Under the assumption of perfect competition (*e.g.*, price equaling marginal cost), we can approximate this shift at the initial equilibrium point as follows:

$$\widehat{mc} = \frac{c}{mc_0} = \frac{c}{p_0}. \tag{4.1b}$$

The with-regulation supply equation can now be written as

$$\hat{q}_s = \varepsilon_s(\hat{p} - \widehat{mc}). \tag{4.1c}$$

Next, we can specify a demand equation as follows:

$$\hat{q}_d = \eta_d \hat{p}, \tag{4.2}$$

where

$\hat{q}_d$	=	percentage change in the quantity of market demand,
η_d	=	market elasticity of demand, and
$\hat{p}$	=	percentage change in market price.

Finally, we specify the market equilibrium conditions in the affected market. In response to the exogenous increase in production costs, producer and consumer behaviors are represented in Eq. 4-1a and Eq. 4-2, and the new equilibrium satisfies the condition that the change in supply equals the change in demand:

$$\hat{q}_s = \hat{q}_d. \tag{4.3}$$

We now have three linear equations in three unknowns ($\hat{p}$, $\hat{q}_d$, and $\hat{q}_s$), and we can solve for the proportional price change in terms of the elasticity parameters (ε_s and η_d) and the proportional change in marginal cost:

$$\begin{gathered} \varepsilon_s(\hat{p} - \widehat{mc}) = \eta_d\hat{p} \\ \varepsilon_s\hat{p} - \varepsilon_s\widehat{mc} = \eta_d\hat{p} \\ \varepsilon_s\hat{p} - \eta_d\hat{p} = \varepsilon_s\widehat{mc} \\ \hat{p}(\varepsilon_s - \eta_d) = \varepsilon_s\widehat{mc} \\ \hat{p} = \frac{\varepsilon_s}{(\varepsilon_s - \eta_d)}\widehat{mc}. \end{gathered} \tag{4.4}$$

Given this solution, we can solve for the proportional change in market quantity using Eq. 4-2.

The change in consumer surplus in the affected market can be estimated using the following linear approximation method:

$$\Delta cs = -(q_1 \times p) + (0.5 \times \Delta q \times \Delta p), \tag{4.5}$$

where q_1 equals with-regulation quantities produced. As shown, higher market prices and reduced consumption lead to welfare losses for consumers.

For affected supply, the change in producer surplus can be estimated with the following equation:

$$\Delta ps = (q_1 \times p) - \big(0.5 \times \Delta q \times (\Delta p - c)\big). \tag{4.6}$$

Increased regulatory costs and declines in output have a negative effect on producer surplus, because the net price change $(\Delta p - c)$ is negative. However, these losses are mitigated, to some degree, as a result of higher market prices.

4.2.2 Model Baseline

Standard EIA practice compares and contrasts the state of a market with and without the final regulatory policy. The EPA selected 2015 as the baseline year for the analysis and collected pulp and paper production and price data for this year from the American Forest and Paper Association and RISI, Inc., respectively. The figures cited were obtained from RISI Inc.'s *PPI Pulp and Paper Week.* Baseline data are reported in Table 4-1.[10]

Table 4-1 Baseline Paper Market Data, 2015 (2016$)

Products	Price[1] ($/ton)	Quantity[2] (tons/year)	% of Total Production
Paper			
Newsprint	$545	1,828,000	2%
Uncoated mechanical	$740	1,500,000	2%
Coated paper	$1,009	5,892,000	7%
Uncoated freesheet	$890	7,924,000	10%
Tissue[3]	$2,538	7,498,000	9%
Other printing/writing	$1,282	4,992,000	6%
Total Paper[4]	**$1,368**	**29,634,000**	**38%**
Paperboard			
Unbleached Kraft paperboard	$638	28,096,000	36%
Semichemical paperboard	$552	10,299,000	13%
Bleached paperboard	$1,201	5,167,000	7%
Recycled paperboard	$1,018	5,807,000	7%
Total Paperboard[4]	**$724**	**49,369,000**	**62%**
Total Paper and Paperboard[4]	**$961**	**$965**	**100%**

[1] Average of monthly prices reported in RISI Inc. (2015a, 2015b, 2015c, 2015d)
[2] American Forest and Paper Association; cited in RISI Inc. (2016)
[3] The EPA was unable to obtain national price averages for tissue paper. For this analysis, the EPA relied upon the price reported by a major tissue producer in their 2015 annual financial report. The price used in this table is the price reported by Clearwater Paper (2016).
[4] Weighted average of individual product prices.

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[10] These prices were inflated to 2016 dollar years, in accordance with OMB Guidance M-17-21 for EO 13771.

Because the paper and paperboard products listed in Table 4-2 below are aggregates of many relatively distinct types of products, the EPA had to choose one product per aggregated product for price information. Ideally, the analyst would use the weighted average of all products within the aggregate product category, but this information is not available to the EPA as of the signature date for this final regulation. With the exception of tissue papers (note footnote in Table 4-2), all product prices were drawn from a RISI, Inc. publication. Table 4-2 lists the aggregated product category and product selected for pricing purposes as representative of the aggregated product.

Table 4-2 Products Used for Price Information

Products	Source	Product Used for Price Information
Paper		
Newsprint	RISI Inc.	30-lb (East)
Uncoated mechanical	RISI Inc.	20.9-lb White directory (mid-point min./max.[1])
Coated paper	RISI Inc.	Economy 8-lb sheets (mid-point min./max.)
Uncoated freesheet	RISI Inc.	50-lb offset, rolls (mid-point min./max.)
Other printing/writing	RISI Inc.	Bleached bristols, 10-pt C1S, rolls (mid-point min./max.)
Paperboard		
Unbleached Kraft paperboard	RISI Inc.	Unbleached kraft (East, mid-point min./max.)
Semichemical paperboard	RISI Inc.	Corrugating Medium, Semichemical (East, mid-point min./max.)
Bleached paperboard	RISI Inc.	Grocery bag, 30-lb (mid-point min./max.)
Recycled paperboard	RISI Inc.	20-pt clay coated news (mid-point min./max.)

[1] For many products, RISI Inc. lists price ranges, based on minimum and maximum prices. We chose to use the midpoint of this range as the price used in the analyses.

4.2.3 Model Parameters

Demand elasticity is calculated as the percentage change in the quantity of a product demanded divided by the percentage change in price. An increase in price causes a decrease in the quantity demanded, hence the negative values seen in Table 4-3, which presents the demand elasticities used in this analysis. Demand is considered elastic if demand elasticity exceeds 1.0 in absolute value (*i.e.*, the percentage change in quantity exceeds the percentage change in price). With a demand elasticity greater than 1.0, then, the quantity demanded is very sensitive to price increases. Demand is considered inelastic if demand elasticity is less than 1.0 in absolute value (*i.e.*, the percentage change in quantity is less than the percentage change in price). Inelastic demand implies that the quantity demanded changes very little in response to price changes.

As shown in Table 4-3, we draw demand elasticities from the North American Pulp and Paper (NAPAP) model, a dynamic model used by the U.S. Forest Service to analyze the paper and paperboard industry (Ince and Buongiorno 2007). The table presents the elasticity estimates, as well as the NAPAP product from which the elasticity estimate is drawn.

Table 4-3 Demand Elasticity Estimates

Products	Elasticity	Source	Source Product
Paper			
Newsprint	-0.22	NAPAP	Newsprint
Uncoated mechanical	-0.40	NAPAP	Uncoated ground wood
Coated paper	-0.40	NAPAP	Coated freesheet
Uncoated freesheet	-0.47	NAPAP	Uncoated freesheet
Tissue	-0.26	NAPAP	Tissue
Other printing/writing	-0.23	NAPAP	Specialty packaging
Paperboard			
Unbleached Kraft paperboard	-0.54	NAPAP	Kraft packaging paper
Semichemical paperboard	-0.43	NAPAP	Corrugating medium
Bleached paperboard	-0.29	NAPAP	Solid bleached board
Recycled paperboard	-0.40	NAPAP	Recycled board

Source: The North American Pulp and Paper (NAPAP) model (Ince and Buongiorno 2007)

Supply elasticity is calculated as the percentage change in quantity supplied divided by the percentage change in price. An upward sloping supply curve has a positive elasticity since price and quantity move in the same direction. If the supply curve has an elasticity greater than one, then supply is considered elastic, which means a small price increase will lead to a relatively large increase in quantity supplied. A supply curve with elasticity less than one is considered inelastic, which means an increase in price will cause little change in quantity supplied. In the long-run, when producers have sufficient time to completely adjust their production to a change in price, the price elasticity of supply is usually greater than one.

As shown in Table 4-4, we draw supply elasticities from the EPA's *Economic Impact and Regulatory Flexibility Analysis of Proposed Effluent Guidelines and NESHAP for the Pulp, Paper, and Paperboard Industry* (U.S. Environmental Protection Agency 1993). The table presents the elasticity estimates, as well as the product, from the 1993 EPA analysis from which each elasticity is drawn.

Table 4-4 Supply Elasticity Estimates

Products	Elasticity	Source	Source Product
Paper			
Newsprint	0.29	U.S. EPA	Newsprint
Uncoated mechanical	0.33	U.S. EPA	Uncoated ground wood
Coated paper	1.65	U.S. EPA	Clay coated printing and converted paper
Uncoated freesheet	0.31	U.S. EPA	Uncoated freesheet
Tissue	0.82	U.S. EPA	Tissue
Other printing/writing	1.20	U.S. EPA	Paper-other
Paperboard			
Unbleached Kraft paperboard	0.32	U.S. EPA	Unbleached Kraft
Semichemical paperboard	0.28	U.S. EPA	Semichemical paperboard
Bleached paperboard	0.68	U.S. EPA	Bleached paperboard for miscellaneous packaging
Recycled paperboard	0.49	U.S. EPA	Recycled paperboard

Source: U.S. Environmental Protection Agency (1993)

4.2.4 Entering Estimated Annualized Engineering Compliance Costs into Economic Model

In order to allocate estimated engineering costs across paper and paperboard product markets used in the partial equilibrium analyses, we first identified the primary product produced by affected mills, classifying the primary product as one of the products used in the economic analysis. Then, using the mill-level estimates of annualized engineering compliance costs, we distributed the costs to products based upon the primary product produced at each mill. Table 4-5 reports the results of this distribution for the proposed and final regulatory options.

Table 4-5 Estimated Annualized Engineering Compliance Costs by Paper Product (thousands 2016$)

Products	Option 1 (proposed)	Option 2 (finalized)
Paper		
Newsprint	$0	$0
Uncoated mechanical	$126	$47
Coated paper	$2,274	$208
Uncoated freesheet	$1,588	$325
Tissue	$167	$93
Other printing/writing	$815	$108
Total Paper	**$4,970**	**$780**
Paperboard		
Unbleached Kraft paperboard	$182	$120
Semichemical paperboard	$2,924	$762
Bleached paperboard	$401	$150
Recycled paperboard	$3	$13
Total Paperboard	**$3,511**	**$1,045**
Pulp		
All pulp products	$4,716	$269
All pulp products	**$4,716**	**$269**
All products	**$13,197**	**$2,094**

Note in Table 4-5 that annualized engineering compliance costs accrue to producers of pulp products. However, in the partial equilibrium models used within this EIA, we are modeling the impacts of compliance costs on prices and quantities of paper products. Because of this, we allocate the annualized engineering compliance costs accruing to pulp producers to producers of paper products that are potentially affected by this rule. This redistribution is based on the strong assumption that impacts on the pulp sector can be reallocated to producers of paper products in proportion to the estimated compliance costs, absent costs expected to accrue to pulp producers. The results of this redistribution are shown in Table 4-6.

Table 4-6 Estimated Annualized Engineering Compliance Costs by Paper Product After Redistributing Estimated Costs to Pulp Producers (thousands 2016$)

Products	Option 1 (proposed)	Option 2 (finalized)
Paper		
Newsprint	$0	$0
Uncoated mechanical	$196	$54
Coated paper	$3,538	$238
Uncoated freesheet	$2,472	$373
Tissue	$260	$106
Other printing/writing	$1,268	$124
Total Paper	**$7,733**	**$895**
Paperboard		
Unbleached Kraft paperboard	$283	$138
Semichemical paperboard	$4,550	$874
Bleached paperboard	$625	$172
Recycled paperboard	$5	$15
Total Paperboard	**$5,464**	**$1,199**
All products	**$13,197**	**$2,094**

Using this engineering cost information and total national production of paper and paperboard products, we estimate the annualized compliance cost per ton of product produced. These annualized engineering compliance costs per ton of product produced are presented in Table 4-7.

Table 4-7 Annualized Engineering Compliance Costs per Ton Product Produced at National Level (in 2016$)

Products	Option 1 (proposed)	Option 2 (finalized)
Paper		
Newsprint	$0.000	$0.000
Uncoated mechanical	$0.129	$2.844
Coated paper	$0.593	$0.545
Uncoated freesheet	$0.308	$0.613
Tissue	$0.034	$0.031
Other printing/writing	$0.251	$0.271
Total Paper	**$0.258**	**$0.470**
Paperboard		
Unbleached Kraft paperboard	$0.010	$0.009
Semichemical paperboard	$0.436	$0.442
Bleached paperboard	$0.119	$0.110
Recycled paperboard	$0.001	$0.001
Total Paperboard	**$0.109**	**$0.109**
All products	**$0.165**	**$0.244**

Note that mills primarily producing newsprint are unaffected by any of the regulatory options. These per-ton of product produced annualized engineering costs estimates were then entered into the series of partial equilibrium market models to estimate impacts on the respective paper and paperboard product markets.

4.2.5 Model Results

Market-level changes in the paper and paperboard markets are estimated to be insignificant. For the finalized amendments, national-level weighted average paper and paperboard prices are predicted to increase less than 0.01 percent, while total quantities are predicted to decrease less than 0.01 percent (Table 4-8).

Table 4-8 Summary of Market Impacts (%) Across Products

Products	Option 1 (proposed)		Option 2 (finalized)	
	Price Change (%)	Quantity Change (%)	Price Change (%)	Quantity Change (%)
Paper				
Newsprint	0.00%	0.00%	0.00%	0.00%
Uncoated mechanical	<0.01%	<-0.01%	<0.01%	<-0.01%
Coated paper	0.05%	-0.02%	<0.01%	<-0.01%
Uncoated freesheet	0.01%	<-0.01%	<0.01%	<-0.01%
Tissue	<0.01%	0.00%	0.00%	0.00%
Other printing/writing	0.02%	<-0.01%	<0.01%	0.00%
Total Paper	**0.01%**	**<-0.01%**	**<0.01%**	**<-0.01%**
Paperboard				
Unbleached Kraft paperboard	<0.01%	0.00%	0.00%	0.00%
Semichemical paperboard	0.03%	-0.01%	<0.01%	<-0.01%
Bleached paperboard	<0.01%	<-0.01%	<0.01%	<-0.01%
Recycled paperboard	0.00%	0.00%	0.00%	0.00%
Total Paperboard	**<0.01%**	**<-0.01%**	**<0.01%**	**<-0.01%**
Total Paper and Paperboard	**0.01%**	**<0.01%**	**<0.01%**	**<0.01%**

Overall, for the final amendments the economic models predict a price increase of about 1 cent per ton of paper and paperboard product, from a baseline price of about $965 per ton (Table 4-9). Overall production quantities are predicted to decrease about 535 tons under the final rule, from a baseline production level of about 79 million tons. Note that, under the finalized amendments, the weighted average price increase is lower than the weighted per ton compliance cost increase of about 3 cents per ton as shown in Table 4-7. As the welfare impacts analysis that follows shows, producers absorb a portion of the regulatory program costs and do not pass on the full burden to consumers.

Table 4-9 Change in Price and Quantity Across Products (costs in 2016$)

Products	Option 1 (proposed)		Option 2 (finalized)	
	Price Change ($/ton)	Quantity Change (tons/year)	Price Change ($/ton)	Quantity Change (tons/year)
Paper				
Newsprint	$0.00	0	$0.00	0
Uncoated mechanical	$0.06	-48	$0.02	-13
Coated paper	$0.48	-1,129	$0.03	-76
Uncoated freesheet	$0.12	-517	$0.02	-78
Tissue	$0.03	-20	$0.01	-8
Other printing/writing	$0.21	-191	$0.02	-19
Total Paper	**$0.20**	**-1,906**	**$0.02**	**-194**
Paperboard				
Unbleached Kraft paperboard	<$0.01	-87	$0.00	-43
Semichemical paperboard	$0.17	-1,237	$0.03	-266
Bleached paperboard	$0.08	-97	$0.02	-29
Recycled paperboard	<$0.01	-1	$0.00	-3
Total Paperboard	**$0.05**	**-1,423**	**$0.01**	**-341**
Total Paper and Paperboard	**$0.10**	**-3,328**	**$0.01**	**-535**

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

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

As shown in Table 4-10, under the finalized amendments, paper and paperboard consumers are predicted to experience a $1.1 million reduction in surplus as the result of higher prices and reduced consumption. Producer surplus is predicted to decrease about $1.0 million. Total welfare losses are then estimated at $2.1 million.

Table 4-10 Summary of Consumer and Producer Surplus Changes in 2020 (millions 2016$)

		Surplus Change (in 2016 dollars)		
Option	**Product Type**	**Consumer**	**Producer**	**Total**
Option 1 (proposed)	Paper	-$5.2	-$2.6	-$7.7
	Paperboard	-$2.3	-$3.1	-$5.5
	Total	**-$7.5**	**-$5.7**	**-$13**
Option 2 (finalized)	Paper	-$0.5	-$0.3	-$0.9
	Paperboard	-$0.5	-$0.7	-$1.2
	Total	**-$1.1**	**-$1.0**	**-$2.1**

4.2.6 Limitations

Ultimately, the regulatory program may cause negligible increases in the costs of supplying paper and paperboard products to consumers. The partial equilibrium model used in this EIA is designed to evaluate behavioral responses to this change in costs within an equilibrium setting within nationally competitive markets. The partial equilibrium model does not model international trade. The national competitive market assumption is clearly very strong because the markets in paper products may be regional for some products, as well as some product markets within the paper industry may be interdependent. Regional price and quantity impacts could be different from the average impacts reported if local market structures, production costs, or demand conditions are substantially different from those used in this analysis.

4.3 Small Business Impacts Analysis

The Regulatory Flexibility Act as amended by the Small Business Regulatory Enforcement Fairness Act (SBREFA) generally requires an agency to prepare a regulatory flexibility analysis of any rule subject to notice and comment rulemaking requirements under the Administrative Procedure Act or any other statute, unless the agency certifies that the rule will not have a significant economic impact on a substantial number of small entities (SISNOSE). Small entities include small businesses, small governmental jurisdictions, and small not-for-profit enterprises.

After considering the economic impact of the final regulatory amendments on small entities, the screening analysis indicates that these amendments will not have a SISNOSE. The supporting analyses for these determinations are presented in this section of the EIA.

4.3.1 Small Business National Overview

The industry sectors covered by the amendments were identified during the development of the engineering cost analysis. The U.S. Census Bureau's Statistics of U.S. Businesses (SUSB) provides national information on the distribution of economic variables by industry and enterprise size. The Census Bureau and the Office of Advocacy of the Small Business Administration (SBA) supported and developed these files for use in a broad range of economic analyses.[11] Statistics include the total number of establishments, and receipts for all entities in an industry; however, many of these entities may not necessarily be covered by the amendments. SUSB also provides statistics by enterprise employment and receipt size.

The Census Bureau's definitions used in the SUSB are as follows:

- **Establishment:** A single physical location where business is conducted or where services or industrial operations are performed.
- **Firm:** A firm is a business organization consisting of one or more domestic establishments in the same state and industry that were specified under common ownership or control. The firm and the establishment are the same for single-establishment firms. For each multi-establishment firm, establishments in the same industry within a state will be counted as one firm- the firm employment and annual payroll are summed from the associated establishments.

[11] See http://www.census.gov/csd/susb/ and http://www.sba.gov/advocacy/ for additional details.

- **Receipts:** Receipts (net of taxes) are defined as the revenue for goods produced, distributed, or services provided, including revenue earned from premiums, commissions and fees, rents, interest, dividends, and royalties. Receipts exclude all revenue collected for local, state, and federal taxes.
- **Enterprise:** An enterprise is a business organization consisting of one or more domestic establishments that were specified under common ownership or control. The enterprise and the establishment are the same for single-establishment firms. Each multi-establishment company forms one enterprise—the enterprise employment and annual payroll are summed from the associated establishments. Enterprise size designations are determined by the sum of employment of all associated establishments.

Because the SBA's business size definitions apply to an establishment's "ultimate parent company," we assumed in this analysis that the "firm" definition above is consistent with the concept of ultimate parent company that is typically used for SBREFA screening analyses, and the terms are used interchangeably.

4.3.2 Small Entity Economic Impact Measures

The amendments will affect the owners of the facilities that will incur compliance costs. The owners, either firms or individuals, are the entities that will bear the financial impacts associated with these additional operating costs. The final amendments have the potential to impact all firms owning affected facilities, both large and small.

The analysis provides the EPA with an estimate of the magnitude of impacts the final amendments may have on the ultimate parent companies that own facilities the EPA expects might be impacted by the final amendments. The analysis focuses on small firms because they may have more difficulty complying with a regulation or affording the costs associated with meeting a revised standard. This section presents the data sources used in the screening analysis, the methodology we applied to develop estimates of impacts, the results of the analysis, and conclusions drawn from the results.

The small business impacts analysis relies upon a series of firm-level sales tests (represented as cost-to-sales ratios) for firms that are likely to be associated with NAICS codes 322110 (pulp mills), 322121 (paper mills), and 322130 (paperboard mills). The EPA obtained firm-level employment, revenues, and production levels using various sources, including

Hoovers, a Dun & Bradstreet database, Manta, and corporate websites. Using these data, we estimated firm-level compliance cost impacts and calculated cost-to-sales ratios to identify small firms that might be significantly impacted by the final amendments.

For the sales test, we divided the estimates of annualized establishment compliance costs at the company-level by estimates of ultimate parent company sales. This is known as the cost-to-revenue ratio, or the "sales test." The "sales test" is the impact methodology the EPA employs in analyzing small entity impacts as opposed to a "profits test," in which annualized compliance costs are calculated as a share of profits. The sales test is often used because revenues or sales data are commonly available for entities impacted by EPA regulations, and profits data normally made available are often not the true profit earned by firms because of accounting and tax considerations. Revenues and sales as typically published are correct figures and are more reliably reported when compared to profit data. The use of a "sales test" for estimating small business impacts for a rulemaking such as this one is consistent with guidance offered by the EPA on compliance with SBREFA[12] and is consistent with guidance published by the U.S. SBA's Office of Advocacy that suggests that cost as a percentage of total revenues is a metric for evaluating cost increases on small entities in relation to increases on large entities.[13]

4.3.3 Small Entity Economic Impact Analysis and Conclusions

As discussed in Section 3, 107 facilities are potentially affected by each of the regulatory options, but as the options increase in stringency the relative impacts increase. Of these 107 facilities, three are owned by small entities. [14] Table 4-11 presents facility names, ultimate owners, number of employees, and estimated sales in 2015 for the three small firms.

[12] The SBREFA compliance guidance to the EPA rulewriters regarding the types of small business analysis that should be considered can be found at https://www.epa.gov/reg-flex/epas-action-development-process-final-guidance-epa-rulewriters-regulatory-flexibility-act. See Table 2 on page 24 of *EPA's Action Development Process, Final Guidelines for EPA Rulewriters: Regulatory Flexibility Act* for guidance on interpretations of the magnitude of the cost-to-sales numbers.

[13] U.S. SBA, Office of Advocacy. *A Guide for Government Agencies, How to Comply with the Regulatory Flexibility Act, Implementing the President's Small Business Agenda and Executive Order 13272*, May 2012 (https://www.sba.gov/sites/default/files/rfaguide_0512_0.pdf).

[14] The small business size threshold for NAICS 322121 (paper mills) is 1,250 employees.

Table 4-11 Potentially Affected Small Entities: Employees and Sales, 2015

Facility	Ultimate Owner	Employees in 2015	Sales in 2015 (million of 2016$)
Cascade Pacific Pulp, LLC	Cascade Pacific Pulp, LLC	185	67
Finch Paper LLC	Finch Paper Holdings LLC	750	90
Woodland Pulp LLC	Woodland Pulp LLC	300	134

Table 4-12 shows that cost-to-sales ratios do not exceed 1 percent for any of the affected small firms for the final option.

Table 4-12 Estimated Annualized Engineering Costs for Potentially Affected Small Entities (costs in 2016$)

	Option 1 (proposed)		Option 2 (finalized)	
Ultimate Owner	Estimated Annualized Costs ($)	Estimated Costs to Sales Ratio	Estimated Annualized Costs ($)	Estimated Costs to Sales Ratio
Cascade Pacific Pulp, LLC	161,094	0.2%	41,940	0.06%
Finch Paper Holdings LLC	14,460	0.02%	49,940	0.06%
Woodland Pulp LLC	30,020	0.02%	41,940	0.03%

The EPA concludes from this analysis that a substantial number of small firms are not significantly impacted. Based upon the analysis in this section, we conclude there is no SISNOSE arising from the finalized amendments.

4.4 Employment Impacts Analysis

Executive Order 13777 directs federal agencies to consider the effect of regulations on jobs, among other regulatory issues and concerns (Executive Order 13777, 2017). Employment impacts of environmental regulations are composed of a mix of potential declines and gains in different areas of the economy over time. A detailed profile of the pulp, paper and paperboard mills sector is included in Section 2 of this EIA, and a discussion of compliance costs, including reporting and recordkeeping requirements, is included in Section 3 of this EIA. Section 2 describes recent economic trends in the pulp, paper, and paperboard mills sector (NAICS 3221), including changes in employment. Table 2-2 shows that from 2008 to 2014 the sector has experienced a decline of less than 5 percent in value of shipments, a decline of approximately 10 percent in the number of establishments, and a decline of just over 13 percent in employment. Table 2-2 also shows that over the same period, the value of shipments per employee increased by about 10 percent. The average number of employees per establishment fell slightly between 2008 and 2014, from 235 to 227.

This section presents an overview of the various ways that environmental regulation can affect employment. EPA continues to explore the relevant theoretical and empirical literature and to seek public comments in order to ensure that the way EPA characterizes the employment effects of its regulations is valid and informative.[15]

4.4.1 Employment Impacts of Environmental Regulation

From an economic perspective, labor is an input into producing goods and services; if a regulation requires that more labor be used to produce a given amount of output, that additional labor is reflected in an increase in the cost of production. Moreover, when the economy is at full employment, we would not expect an environmental regulation to have a net impact on overall employment because labor is being shifted from one sector to another. On the other hand, in periods of high unemployment, net employment effects (both positive and negative) are possible.

For example, an increase in labor demand due to regulation may result in a short-term net increase in overall employment as workers are hired by the regulated sector to help meet new requirements (*e.g.*, to install new equipment) or by the environmental protection sector to produce new abatement capital resulting in hiring previously unemployed workers. When significant numbers of workers are unemployed, the opportunity costs associated with displacing jobs in other sectors are likely to be higher. And, in general, if a regulation imposes high costs and does not increase the demand for labor, it may lead to a decrease in employment. The responsiveness of industry labor demand depends on how these forces all interact. Economic theory indicates that the responsiveness of industry labor demand depends on a number of factors: price elasticity of demand for the product, substitutability of other factors of production, elasticity of supply of other factors of production, and labor's share of total production costs.

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

Berman and Bui (2001) put this theory in the context of environmental regulation, and suggest that, for example, if all firms in the industry are faced with the same compliance costs of regulation and product demand is inelastic, then industry output may not change much at all.

Regulations set in motion new orders for pollution control equipment and services. New categories of employment have been created in the process of implementing environmental regulations. When a regulation is promulgated, one typical response of industry is to order pollution control equipment and services in order to comply with the regulation when it becomes effective. On the other hand, the closure of plants that choose not to comply – and any changes in production levels at plants choosing to comply and remain in operation – occur after the compliance date, or earlier in anticipation of the compliance obligation. Environmental regulation may increase revenue and employment in the environmental technology industry. While these increases represent gains for that industry, they translate into costs to the regulated industries required to install the equipment.

Environmental regulations support employment in many basic industries. Regulated firms either hire workers to design and build pollution controls directly or purchase pollution control devices from a third party for installation. Once the equipment is installed, regulated firms hire workers to operate and maintain the pollution control equipment—much like they hire workers to produce more output. In addition to the increase in employment in the environmental protection industry (via increased orders for pollution control equipment), environmental regulations also support employment in industries that provide intermediate goods to the environmental protection industry. The equipment manufacturers, in turn, order steel, tanks, vessels, blowers, pumps, and chemicals to manufacture and install the equipment.

Berman and Bui (2001) demonstrate using standard neoclassical microeconomics that environmental regulations have an ambiguous effect on employment in the regulated sector. The theoretical results imply that the effect of environmental regulation on employment in the regulated sector is an empirical question. Berman and Bui (2001) developed an innovative approach to examine how an increase in local air quality regulation that reduces nitrogen oxides (NO_X) emissions affects manufacturing employment in the South Coast Air Quality Management District (SCAQMD), which incorporates Los Angeles and its suburbs. During the time frame of their study, 1979 to 1992, the SCAQMD enacted some of the country's most stringent air quality regulations. Using SCAQMD's local air quality regulations, Berman and Bui identify the effect of environmental regulations on net employment in the regulated industries.[16] The authors find that "while regulations do impose large costs, they have a limited effect on employment" (Berman and Bui 2001, p. 269). Their conclusion is that local air quality regulation "probably increased labor demand slightly" but that "the employment effects of both compliance and increased stringency are fairly precisely estimated zeros, even when exit and dissuaded entry effects are included" (Berman and Bui 2001, p. 269).[17]

While there is an extensive empirical, peer-reviewed literature analyzing the effect of environmental regulations on various economic outcomes including productivity, investment, competitiveness as well as environmental performance, there are only a few papers that examine the impact of environmental regulation on employment, but this area of the literature has been growing. As stated previously in this EIA section, empirical results from Berman and Bui (2001) suggest that new or more stringent environmental regulations do not have a substantial impact on net employment (either negative or positive) in the regulated sector. Similarly, Ferris, Shadbegian, and Wolverton (2014) also find that regulation-induced net employment impacts are close to zero in the regulated sector. Furthermore, Gray *et al.* (2014) find that pulp mills that had to comply with both the air and water regulations in the EPA's 1998 "Cluster Rule" experienced relatively small and not always statistically significant, decreases in employment. Nevertheless, other empirical research suggests that more highly regulated counties may generate fewer jobs than less regulated ones (Greenstone 2002, Walker 2011). However, the methodology used in these two studies cannot estimate whether aggregate employment is lower or higher due to more stringent environmental regulation, it can only imply that relative employment growth in some sectors differs between more and less regulated areas. List *et al.* (2003) find some evidence that this type of geographic relocation, from more regulated areas to less regulated areas may be occurring. Overall, the peer-reviewed literature does not contain evidence that environmental regulation has a large impact on net employment (either negative or positive) in the long run

[16] Berman and Bui include over 40 4-digit SIC industries in their sample.

[17] Including the employment effect of exiting plants and plants dissuaded from opening will increase the estimated impact of regulation on employment.

across the whole economy.

While the theoretical framework laid out by Berman and Bui (2001) still holds for the industry affected under these final amendments, important differences in the markets and regulatory settings analyzed in their study and the setting presented here lead us to conclude that it is inappropriate to use their quantitative estimates to estimate the net employment impacts from these final amendments. In particular, the industries used in these two studies as well as the timeframe (late 1970's to early 1990's) are quite different than those in this rule.

The preceding sections have outlined the challenges associated with estimating net employment effects in the regulated sector and in the environmental protection sector. These challenges make it very difficult to accurately produce net employment estimates for the whole economy that would appropriately capture the way in which costs, compliance spending, and environmental benefits propagate through the macro-economy. Given the difficulty with estimating national impacts of regulations, the EPA has not generally estimated economy-wide employment impacts of its regulations in its benefit-cost analyses. However, in its continuing effort to advance the evaluation of costs, benefits, and economic impacts associated with environmental regulation, the EPA has formed a panel of experts as part of the EPA's Science Advisory Board (SAB) to advise the EPA on the technical merits and challenges of using economy-wide economic models to evaluate the impacts of its regulations, including the impact on net national employment.[18] Once the EPA receives guidance from this panel, it will carefully consider this input and then decide if and how to proceed on economy-wide modeling of net employment impacts of its regulations.

4.4.2 Labor Estimates Associated with Final Amendments

The labor estimates associated with the regulatory options for opacity for recovery furnaces and lime kilns, as well as the incremental increases in recordkeeping and reporting, are presented below in Table 4-13. We convert estimates of the number hours of labor required to full-time equivalents (FTEs) by dividing by 2,080 (40 hours per week multiplied by 52 weeks). We note that this type of FTE estimate cannot be used to make assumptions about the specific

[18] For further information see: http://yosemite.epa.gov/sab/sabproduct.nsf/0/07E67CF77B54734285257BB0004F87ED?OpenDocument

number of people involved or whether new jobs are created for new employees. In this EIA, we make no distinction in the quantitative estimates between labor changes within and outside of the regulated sector.

Table 4-13 Labor-based Employment Estimates for Operating and Maintaining Control Equipment Requirements

	Option 1 (proposed)	Option 2 (finalized)
Recovery Furnace Opacity Limit Final Amendments		
Nationwide Labor (hrs)	4,200	0
Full-time Equivalents (FTE)	2	0
Incremental Reporting and Recordkeeping		
Nationwide Labor (hrs)	12,464	11,488
Full-time Equivalents (FTE)	6	6
Total		
Nationwide Labor (hrs)	16,664	11,488
Full-time Equivalents (FTE)	8	6

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