Economic Impact Analysis For the Proposed Cyanide Manufacturing NESHAP

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1. OVERVIEW

The EPA is proposing national emission standards for hazardous air pollutants (NESHAP) that will affect major sources of hazardous air pollutant (HAP) emissions in covered under the cyanide chemicals manufacturing source category. Cyanides manufacturing is classified under Standard Industrial Classification (SIC) code 2819 and North American Industrial Classification System (NAICS) code 325188.

This analysis provides a brief economic profile of the cyanide chemicals manufacturing industry, an overview of the HAP emissions and proposed NESHAP, and a screening analysis of the impact the proposed NESHAP will have on firms in the cyanide chemicals manufacturing source category.

2. INDUSTRY PROFILE

What are cyanide chemicals?

This standard focuses on the production of sodium cyanide (NaCN) and hydrogen cyanide (HCN). NaCN is a white, cubic crystalline solid. Odorless when dry, it gives off the smell of bitter almonds when damp. It is used in extracting gold and silver from ore, electroplating, case hardening of metals, chelating agents production, hydrocyanic acid production, and dye and pigment manufacturing. It is typically shipped off-site for use by other manufacturing industries.

HCN is a highly toxic, colorless liquid with the odor of bitter almonds. It is mostly used to make adiponitrile (used to produce nylon 66), and acetone cyanohydrin (used to produe methyl methacrylate), and other chemicals. Because it is highly toxic, it is usually manufactured on-site by manufacturers of these chemicals (Brown).

How is sodium cyanide (NaCN) made?

NaCN is produced when hydrocyanic acid is neutralized with aqueous sodium hydroxide, producing a slurry. The slurry is crystallized, and the NaCN solids are separated, dried, and prepared for shipping (Brown).

How is hydrogen cyanide (HCN) made?

HCN is mostly made using the Andrussow process, where ammonia, air, and natural gas are reacted over a platinum/rhodium catalyst at high heat (Brown). The Blausaure Methane Anlage is also used; it differs from the Andrussow process in that air is not fed into the reactor (Johnson, July 1996).

HCN is also made as a byproduct of the Sohio process, used to make acrylonitrile. In this process, propylene, anhydrous ammonia, and air are combined in a reactor to produce acrylonitrile, HCN and acetonitrile. The separate products are then distilled, separated, and purified (Johnson, July 1996).

What are the end uses for cyanide?

Tables 1 and 2 below provide a breakdown of the end uses of HCN and NaCN. Over 90% of NaCN is used in extracting gold from ore. Small quantities are also used in electroplating, and chemical synthesis (Chemical Market Reporter 6/28/99). HCN is mostly used as a raw material in the production of fibers, plastics, polymers, resins, and coatings. Nearly 90% of HCN is used as a raw material for adiponitrile (used in producing nylon 66 for fiber and plastic production), acetone cyanohydrin production (to produce methyl methacrylate for acrylic plastics and resins, protective coatings, plastic additives, and emulsion polymers), and NaCN production.

Table 1 - Hydrogen Cyanide (HCN) Uses and Estimated Consumption

Use	Estimated consumption, 1998 (Million lbs/yr)	Percent of total estimated consumption
Adiponitrile production (used in making nylon 66 for fiber and plastic production)	590	41
Acetone cyanohydrin production (for methyl methacrylate, used to make acrylic plastics and resins, protective coatings, plastic additives, and emulsion polymers)	461	32
Sodium cyanide production	202	14
Other	187	13
Total	1,440	100

Source: Chemical Market Reporter, 11/23/98

Table 2 - Sodium Cyanide (NaCN) Uses and Estimated Consumption		
Use	Estimated consumption (Million lbs/yr)	Percent of total estimated consumption
Gold extraction	130	93
Electroplating, chemical, synthesis, and other uses	10	7
Total	140	100

References: Johnson (June 1996)

What companies/facilities make cyanide?

The EPA has identified 16 domestic cyanide manufacturing facilities, owned and operated by 12 companies. Twelve of these facilities are located in the southern U.S.; eight are located in Texas. All 16 firms produce HCN; 5 of the 16 firms produce sodium cyanide as well. Table 3 lists the companies and facilities that manufacture sodium cyanide and hydrogen cyanide, the production processes, and the production capacity for each facility.

Table 3 - Cyanide Manufacturing Facilities and Estimated Production Capacity					
Company	Location	Employment	HCN Production Process	HCN Production Capacity (tons/year)	NaCN Production Capacity (tons/year)
BP Chemicals	Lima, OH	96,650	Sohio	40	
	Port Lavaca, TX		Sohio	72	
Cyanco*	Winnemucca, NV	25,100*	Andrussow	24	43
Cytec	Westwego, LA	5,000	Sohio	65-80	
Degussa	Theodore, AL	25,000	BMA	53	60
Dow Chemical	Freeport, TX	39,000	Andrussow	20	
Du Pont	Beaumont, TX	97,000	Sohio	55-90	
	Memphis, TN		Andrussow	200	200
	Orange, TX		Andrussow	320	
	Victoria, TX		Andrussow	400	
FMC Corp.	Green River, WY	17,000	Andrussow	33	60
Monsanto	Alvin, TX	32,000	Sohio	55-100	
Novartis Crop Protection, Inc.	St. Gabriel, LA	100,000	Andrussow	100	
Rhone-Poulenc	Institute, WV	65,0000	Andrussow	15	
Rohm & Haas	Deer Park, TX	20,000	Andrussow	200	
Sterling Chemicals	Texas City, TX	1,180	Sohio	75	80
Production Totals				1727-1823	442

* - joint venture of Mining Services International and Degussa. Employment figures represent combined employment of both parent corporations.

Source: Brown

What are the production costs for cyanide manufacturing?

Scant information on HCN and NCN production costs is available. The U.S. Census Bureau's 1997 Economic Census includes cyanide manufacturing operations with other chemical production facilities in NAICS 325188 under the category "All Other Basic Inorganic Chemical Manufacturing." The Census Bureau's "Annual Report on Inorganic Chemicals - 1997" appears to subclassify HCN under "inorganic acids, except nitric, phosphoric and sulfuric" (product code 2819451), and provides production quantities and values for HCN, but no specific production costs for HCN. No apparent breakout of NCN costs is provided.

What are the pricing trends for sodium cyanide?

Information on pricing for sodium cyanide over the past decade is limited, and can only be pieced together from several sources. The information suggests a wide fluctuation in prices over the last decade. In the mid-1989, NaCN prices rose to the 85-90 cent per pound range, but fell to 80-85 cent per pound range in 1990. Prices in 1992 reportedly ranged from 79 to 85 cents per pound. (Chemical Marketing Reporter, 12/7/92). This price trend continued through the first part of 1993, but fell to the low 50s in the latter part of that year. In early 1994, prices were reported to be 60 cents per pound. (Chemical Marketing Reporter, 1/10/94). DuPont estimated that 450,000 metric tons of NaCN were consumed worldwide in 1994. If, as SRI suggests, this reflects a global value of $675 million using late 1995 market prices, this would mean a rough mid-1990's price of 68 cents per pound of NaCN. DeGussa was reported in August 1996 to have raised the base price for NaCN to $1650/tonne CFR main port, or around 74 cents per pound. (European Chemical News).

While no current pricing information on NaCN is available, gold prices have been falling since the mid-1990s. Demand for NaCN was reportedly 3-4% lower in 1999 than in 1996. Despite price decreases (of unreported magnitude), demand is expected to stay flat in the near future. (Chemical Market Reporter, 2/15/99)

What are the pricing trends for hydrogen cyanide?

Prices for liquid HCN in tanks appear to have held fairly steady in the years 1990-1996 at around 60 cents per pound. Since very little HCN produced is sold, published prices may not fully represent transaction values. (Johnson, July 1996; Chemical Marketing Reporter, 1/10/94). List prices for HCN have not been published since the mid-1990s. However, average sale values from Bureau of the Census reports indicate prices ranging from 25 to 31 cents per pound over the years 1990-1995. Projected average HCN sales values for 1996 and 1998 were 32 and 33 cents per pound, respectively (Chemical Products Synopsis, November 1996).

How much cyanide is imported to/exported from the United States?

HCN is not believed to be imported to, or exported from the United States, since most of the product is consumed at its production site.

According to the U.S. Census Bureau, 7.1 million pounds of NaCN was imported into the United States in 1995, an increase from 5.7 million pounds the previous year. NaCN imports peaked in 1988 at 63.4 million pounds, and declined steadily until 1995. Most imports have come from Germany and the United Kingdom. No more recent data is available.

In 1995, the United States exported 179 million pounds of NaCN to other countries. Exports fell from 143 million pounds in 1990 to 104 million pounds in 1991, but steadily increased over the next four years. Canada was the leading recipient of U.S. exports in 1995 with nearly 40 million tons, followed by Bolivia (23 million tons) and Ghana (22.5 million tons) (Johnson, June 1996).

Are there consumer substitutes for cyanide?

HCN is primarily used to make intermediates for other products - adiponitrile and acetone cyanohydrin (which in itself is an intermediate for methyl methacrylate). While adiponitrile is the dominant intermediate for nylon-6,6, it can also be made from adipic acid, butadiene, or acrylonitrile (Chemical Week Buyers Guide). As for methyl methacrylate, methods exist to produce it using C-3 and C-4 hydrocarbons instead of acetpme cyanohydrine (Chemical Market Reporter, 11/23/98).

Thiosulfate is considered a promising substitute for NaCN in removing gold from certain ores, because it poses less environmental risk, and could be comparable in cost to NaCN (American Metal Market). While thiosulfate has been shown to work on low grade carbanaceous ores, more research is needed to determine how it would be used on a large mining scale. (Chemical Marketing Reporter, 12/5/94).

What is the anticipated growth for the cyanide industry over the next few years?

For NaCN, demand is reportedly 3 to 4% lower than in 1996, and is expected to stay flat for the next several years. The price of gold has fallen over the past few years, resulting in reduced demand for NaCN. At least one major joint venture to increase plant capacity has been put on hold, as a result (Chemical Market Reporter, 2/15/99).

For HCN, overall demand is expected to grow at around 2% per year through the year 2002. This growth mirrors the projected growth for adiponitrile (a result of increasing demand for nylon-6,6), plastics, and resins over the next decade (Chemical Market Reporter, 11/23/98).
Based on 1997 U.S. production amounts (3,650 million lbs) and reported capacity (approximately 4,000 million lbs), it appears reasonable that the projected growth over the next few years could be absorbed by existing facilities without need for expansion or new facilities.

3. HAP EMISSIONS AND PROPOSED CONTROLS

What HAP are emitted from cyanide manufacturing facilities?

In the production of HCN, the main HAP of concern is the product itself - HCN. In addition, some facilities report emissions of acetonitrile and acrylonitrile. Similarly, for NaCN production, NaCN and HCN are the major HAP emitted (Brown).

What are the sources of HAP emissions in cyanide manufacturing facilities?

Data obtained by the EPA, indicate that process vents account for the majority of HAP emissions from cyanide manufacturing. Other sources of emissions include storage vessels and transfer operations. In addition, equipment leaks and wastewater (and, in the case of NaCN, solids handling operations) are sources of fugitive emissions (Brown).

What level of control does the proposed rule specify for affected facilities?

The proposed MACT floor levels of control for identified HAP emission points at cyanide manufacturing facilities are shown in Table 4. For the most part, MACT floor levels of control for existing and new sources are identical, with the exception of some sodium cyanide process vents at the dry end of the process.

Table 4 - MACT Floor for Cyanide Chemicals Manufacturing Facilities			
Emission Source Type		**Existing Source MACT Floor**	**New Source MACT Floor**
Storage Vessels		98% emission reduction (by weight) through use of flare or other control device	98% emission reduction (by weight) through use of flare or other control device
Equipment Leaks		Leak dectection and repair complying with 40 CFR part 60, subpart VV	Leak dectection and repair complying with 40 CFR part 60, subpart VV
Transfer Operations		98% emission reduction (by weight) through use of flare or other control device	98% emission reduction (by weight) through use of flare or other control device
Wastewater		Biotreatment	Biotreatment
Process Vents	Andrussow or BMA	Overall emission reduction of 99.9% (by weight) during normal operations	Overall emission reduction of 99.9% (by weight) during normal operations
		Use of flare during startup, shutdown, and malfunction	Use of flare during startup, shutdown, and malfunction
	Sodium Cyanide - Wet End	Overall emission reduction of 98% (by weight)	Overall emission reduction of 98% (by weight)
	Sodium Cyanide - Dry End	Overall emission reduction of 91% (by weight)	Overall emission reduction of 98.9% (by weight)
	Sohio	Overall emission reduction of 98% (by weight)	Overall emission reduction of 98% (by weight)

4. COSTS AND IMPACTS

What costs will this proposed regulation impose on the cyanide chemicals manufacturing source category?

To estimate impacts and costs of the proposed NESHAP, EPA developed eight model plants to represent the cyanide chemicals manufacturing industry. Table 5 summarizes the control technologies required by each model plant to meet the proposed MACT floor. Based on the criteria established in the proposed NESHAP, EPA believes that 14 facilities will need to add control equipment in order to comply with the proposed rule. The EPA estimates the total annual cost for these facilities combined to be approximately $2.4 million per year. Table 6 below provides a breakdown of this total annual cost, including capital recovery, labor, maintenance, energy, and administrative costs. Table 7 below provides a breakdown of the estimated annual costs for each model plant.

Table 5 - Model Plant Characteristics for Cyanide Chemicals Manufacturing NESHAP						
Model Plant	Manufacturing Process	Controls Required to Meet the MACT Floor by Emission Source Type				
		Process Vents	Storage Vessels	Equipment Leaks	Transfer Operations	Wastewater
1	Andrussow/BMA	None	None	None	None	None
2	Andrussow/BMA	Thermal Incinerator	Thermal Incinerator	None	None	None
3	Andrussow/BMA	None	None	Modify existing LDAR program to comply with MACT	None	None
4	Andrussow/BMA	None	None	Implement LDAR program to comply with MACT	None	None
5	NaCN	None	None	None	None	None
6	NaCN	Flare	None	None	None	None
7	Sohio	None	None	None	None	None
8	Sohio	Flare	None	Modify existing LDAR program	None	None

Table 6 - Annual Costs for Cyanide Chemicals Manufacturing NESHAP

Cost component		Amount ($)
Fixed Control Costs	Annualized Capital	153,528
	Overhead	134,735
	Property taxes	13,612
	Insurance	13,612
	Administrative fees/charges	27,225
Variable Control Costs	Raw materials (process)	8
	Raw materials (maintenance)	100,524
	Energy/utilities	844,049
	Labor	261,778
	Replacement parts	20,008
Monitoring/Recordkeeping Costs		813,140
Total Annual Costs		2,382,219

Table 7 - Annual Costs for Cyanide Model Plants

Cost Component		Model Plant Costs ($)							
		1 Andrussow/ BMA (2 facilities)	2 Andrussow/ BMA (1 facility)	3 Andrussow/ BMA (4 facilities)	4 Andrussow/ BMA (2 facilities)	5* NaCN (2 facilities)	6* NaCN (1 facility)	7 Sohio (3 facilities)	8 Sohio (2 facilities)
Fixed Control Costs	Annualized Capital	n/a	12,024	18,077	19,718	n/a	5,368	n/a	12,196
	Overhead Allocation	n/a	9,366	13,559	13,559	n/a	11,303	n/a	16,356
	Property Tax	n/a	845	1,666	1,666	n/a	489	n/a	1,141
	Insurance	n/a	845	1,666	1,666	n/a	489	n/a	1,141
	Administrative Fees	n/a	1,689	3,332	3,332	n/a	978	n/a	2,283
Variable Control Costs	Raw Materials (Process)	n/a	n/a	n/a	n/a	n/a	8	n/a	n/a
	Raw Materials (Maintenance)	n/a	7,805	9,438	9,438	n/a	9,419	n/a	13,336
	Energy/Utilities	n/a	30,792	n/a	n/a	n/a	761	n/a	406,248
	Labor	n/a	7,805	33,897	33,897	n/a	9,419	n/a	20,586
	Replacement Parts	n/a	n/a	3,240	3,240	n/a	n/a	n/a	324
Monitoring/Recordkeeping		56,414	58,462	59,076	59,076	n/a	n/a	56,414	59,076
Total		56,414	129,633	143,951	145,592	n/a	38,234	56,414	532,689

*Only 14 facilities are considered major sources, but three of them are HCN facilities colocated with NCN facilities - hence the total number of 17 plants cited above. Model plant 5 is colocated with model plant 8; its MRR costs are included under model plant 8. Model plant 6 is colocated with model plant 2; its MRR costs are included under model plant 2.

What is the anticipated impact of control costs on the industry?

To assess the impact of the impact the proposed NESHAP would have on the industry, EPA performed a "sales test" as a initial impacts screening for affected firms in the industry. Under this analysis, EPA looked at the annualized cost of compliance with the rule as a percentage of annual sales. Using this approach, if a firm has a cost-to-sales ratio of 1% or less, it is presumed that the regulation has no significant economic impact, it may experience some degree of significant impact.

The EPA was able to identify sales information for all of the firms subject to the proposed rule, and assigned a model plant to each facility, based on the type of process used. The results of this screening are shown in table 8 below. Because Cyanco and Monsanto are not considered major sources of HAP emissions, they would not be affected by the proposed rule, and were not included in this screening analysis.

Table 8 - Screening Analysis for Firms Affected by the Proposed Rule

Company (& number of facilities affected by rule, if more than one)	Production Process	Model Plants Assigned to Company	Annualized cost of control, including MIRR ($000)	Parent Company Total Sales for 1998 ($000)*	Cost-to-Sales Ratio (%)
BP Chemicals (2 facilities)	Sohio	7, 7	$113	$83,732,000	≤0.001
Cytec	Sohio	7	56	1,444,500	≤0.001
Degussa	BMA and NaCN	4, 5	146	14,856,600	≤0.001
Dow Chemical	Andrussow		56	18,441,000	≤0.001
Du Pont (4 facilities)	Sohio (1 facility), Andrussow (2 facilities), Andrussow and NaCN (1 facility)	1, 3, 4, 6, 8	881	24,767,000	≤0.001
FMC Corp.	Andrussow and NaCN	3	144	1,909,100	≤0.001
Novartis	Andrussow	3	144	23,102,000	≤0.001
Rhone-Poulenc	Andrussow	3	144	13,200,000	≤0.001
Rohm & Haas	Andrussow	2	130	6,448,000	≤0.001
Sterling Chemicals	Sohio and NaCN	5, 8	533	822,590	≤0.001

* - All sales data compiled from company annual reports, except for Sterling Chemical sales figures, which were found in its 10-K report to the SEC.

As shown in the preceeding table, no firm has a cost-to-sales ratio that exceeds 1%. The firm with the highest cost-to-sales ratio is Sterling Chemical, with a ratio of over six-hundredths of a percent. Based on this screening analysis, EPA therefore concludes that the proposed cyanide chemicals manufacturing NESHAP will cause no significant impact on any of the sources affected by the rule.

Are any small businesses significantly impacted by this NESHAP?

No. The Regulatory Flexibility Act (RFA), as amended by the Small Business Regulatory Enforcement Fairness Act (SBREFA) of 1996, requires Federal regulatory agencies to determine whether a proposed or final regulation will have a significant impact on a substantial number of small entities. For SIC 2819, a small entity is defined by the Small Business Administration as a firm with 500 or fewer employees (a small entity cut-off for NAICS 325188 will not be available before October 1, 2000). This cut-off is made based on parent company employment. At this time, no parent company included in the cyanide chemical manufacturing source category has been identified as having 500 or fewer employees. Therefore, the EPA does not believe that the proposed carbon black NESHAP will have a significant impact on a substantial number of small entities.

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