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PERLITE INDUSTRY SOURCE CATEGORY SURVEY

Emission Standards and Engineering Division

U.S. ENVIRONMENTAL PROTECTION AGENCY

OFFICE OF AIR, NOISE, AND RADIATION

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Abstract

Background information is presented on the perlite industry for the purpose of determining the need for a new source performance standard (NSPS). The industry is surveyed and categorized by plant, process, and other factors. Information is presented on processes, emissions and air pollution control equipment. State and local regulations are summarized. The impact of a potential NSPS on particulate emissions is calculated.

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1. SUMMARY

Perlite is a glassy volcanic rock that expands up to 20 times its original volume when heated to between 1033 and 1366K (1400° and 2000°F).[1] Both perlite ore and the expanded product are referred to as "perlite." Commercial production of expanded perlite has grown steadily since its introduction as a commercial product 33 years ago and is expected to continue through the year 2000.

Expanded perlite is used primarily in the building construction field as a lightweight aggregate. Principal uses include plaster and concrete aggregate, loose-fill insulation, insulation board, and ceiling tile.

Crude perlite is produced by 12 companies in six western states. In 1978 total domestic crude perlite production was 854 Gg (939,000 tons), with New Mexico accounting for 86 percent of this production.[2] During the same year, 80 plants in 33 states produced 503 Gg (553,000 tons) of expanded perlite.[2] Exports of crude perlite account for the difference between the crude and expanded production rates.

Four companies with 12 plants produce over 60 percent of the expanded perlite manufactured in the United States. The majority of the 80 expansion plants are small, independent companies producing less than 9.1 Gg/year (10,000 tons/year).[3]

Perlite dryers, expansion furnaces, and material handling at expansion plants are included in the source catagory survey. Specifically excluded are processes covered by the nonmetallic minerals source category.

Crude perlite is mined using open pit techniques. Milling operations (crushing, drying, screening) generally occur at the mine site prior to shipment to expanding plants. The low density, bulky characteristic of expanded perlite favor the location of expansion plants near market areas.

Perlite ore is dried following primary crushing in order to facilitate screening/sizing operations. Gas- or oil-fired rotary kilns are used to heat the crude perlite to approximately 366K (200^oF), thereby reducing excess free moisture.

Sized, crude perlite particles produced by milling facilities are shipped in bulk to expansion plants. The crude feed is introduced into vertical or horizontal rotary furnaces where it is heated to an appropriate temperature within the softening range which is between 1033 and 1366K (1400^o and 2000^oF). The extremely light expanded particles are conveyed pneumatically to a cyclone and/or baghouse for classification and collection. The expanded perlite is then bagged or shipped in bulk by rail or truck.

Particulates are the major air pollutant released during the processing of crude and expanded perlite. Emissions from the dryers result when fines produced during the crushing operation become entrained in the exhaust gases.

Similarly, particulates are emitted from expansion furnaces because some material escapes the cyclone or baghouse product collection system. At expanding plants particulate emissions also come from handling both the crude feed and expanded product.

Little data are available on the uncontrolled emission rates from these sources. Estimates have been developed by analogy to similar processes (phosphate rock drying) or extrapolation from the few perlite test results for perlite dryers and for fugitive emissions from expanding plants. The published emission factor for expansion furnaces is used although it also could not be verified by test data.

Table 1-1. UNCONTROLLED EMISSION FACTORS

Source	Basis	Uncontrolled emission factor[4,5,6]	
		kg/Mg	lb/ton
Dryers	Crude perlite dried	9.0	18
Expansion furnaces	Crude perlite expanded	10.5	21
Fugitive emissions at expansion plant	Crude perlite expanded	0.9	1.9

For control of particulate emissions from dryers, 12 mills use fabric filters and 1 mill uses a scrubber. In many cases particulate emission from material handling processes and from the dryers are controlled by the same device. Results from two emission tests on fabric filters indicate an average emission rate of 0.18 kg/Mg (0.37 lb/ton).[7] This corresponds to an efficiency of 98 percent based on the emission factor in Table 1-1. Data on the performance of the scrubber are not available.

For control of particulate emissions from expanding furnaces, fabric filters or scrubbers are used. Fabric filters are used in over 90 percent of the plants.[3] Data are lacking on the performance of these filters and scrubbers, but available information suggests that a well maintained baghouse controls expanding furnace emissions to a rate of approximately 0.21 kg/Mg (0.42 lb/ton) to 0.05 kg/Mg (0.10 lb/ton). This corresponds to a collection efficiency of 98 percent to 99.5 percent.[8,9]

It is estimated that in 1978 total annual particulate emissions from perlite operations were:

- Dryers 154 Mg (169 tons)
- Expanding furnaces 106 Mg (116 tons)
- Fugitive (expanding plants) 241 Mg (265 tons)

In comparison, nationwide particulate emissions were estimated to be about 8.2 Tg (9×10^6 tons) in 1978.[10]

Assuming that a standard of performance for new sources (NSPS) required 99.5 percent efficient control devices and that the present state regulations require 98 percent, the impact of the standard would be to reduce 1985 nationwide emissions from the anticipated three new perlite dryers by 47 Mg (52 tons) and from expansion plants by 45 Mg (49 tons). (See Appendix A.) This level of control is considered to be the best demonstrated technology for this source category, after accounting for cost and the small size of most facilities.

It is recommended that no standard be developed for the perlite source category because:

- The nationwide particulate reduction would be only 92 Mg/year (101 tons/year) in 1985

- Individual plants are small; hence there are no large local perlite sources with a significant ambient impact

It is also recommended that development of a standard for dryers for all groups of similar nonmetallic minerals be studied. Dryers appear to be a significant source and 18 of the 20 nonmetallic minerals utilize dryers.[11] However, dryers are not currently covered in the nonmetallic minerals standard under development.

2. INTRODUCTION

The Clean Air Act (CAA), as amended in 1977, provides authority for the U.S. Environmental Protection Agency (EPA) to control discharge of pollutants into the atmosphere. The Act contains several regulatory and enforcement options for control of emissions from stationary sources. Options include: (1) National Ambient Air Quality Standards (NAAQS) on the national level and State Implementation Plans (SIP's) on the state level, (2) New Source Performance Standards (NSPS's) and (3) National Emission Standards for Hazardous Air Pollutants (NESHAP's).

Section 111 of the CAA calls for promulgation of NSPS's for new and modified sources which may contribute significantly to air pollution, the emission of which could endanger public health or welfare. The standards must reflect the best degree of control as satisfactorily demonstrated to EPA (taking cost, energy, and non-air environmental quality impacts into account). This source category survey is the first step in the process of setting an NSPS for perlite. Its primary purpose is to verify whether or not a standard is warranted and, if warranted, to determine the availability of data required to set a standard.

Information for the source category survey was gathered through the following activities:

1. Population and growth from literature searches, contacts with federal agencies, data from individual states, and discussions with industry representatives
2. Data on emissions and applicable control devices from literature searches, National Emissions Data System (NEDS), contacts with federal, state, and local air pollution control agencies, records of the agencies, contacts with industry representatives, and site visits to five plants
3. State and local regulations from contacts with the authorities who are responsible for air pollution control in the area

Information on production rates, emissions, and control technologies for individual plants was often incomplete and difficult to complete or verify. Industry personnel were reluctant to give specific figures, since they considered the data to be proprietary information that could aid competitors. A telephone survey of state regulatory agencies indicated that because perlite plants are generally considered to be relatively minor pollutant sources, they are frequently assigned a low enforcement priority.[12]

An important issue throughout the information collection, analysis, and documentation effort has been the relationship with the nonmetallic mineral processing source category. For this study, the issue was resolved by identifying perlite facilities as the dryers at the mills, where crude perlite ore is crushed and sized, and the expanding furnaces and material handling facilities at expanding plants. Consequently, screening operations, material handling, and bagging operations were included at the expanding plants but not at the mills. The nonmetallic mineral processing standard will address material handling and associated processes at the mills, if promulgated as proposed to the steering committee.

Secondary processes such as the manufacturing of building board with perlite additives were not included in the source category survey. The inclusion of such end-use manufacturing operations would result in many diverse sources being included with different emission problems, control problems, and economic characteristics.

The result of the definition was to limit the study to dryers at 13 mills and the expanding and material handling processes at 80 perlite expansion plants.

3. CONCLUSIONS AND RECOMMENDATIONS

3.1 CONCLUSIONS

The production of both crude and expanded perlite is expected to grow at 4.0 and 5.9 percent/year, respectively, through 1985.[1] Thereafter, the growth rates for both crude and expanded perlite are expected to decrease to approximately 3.6 percent/year.[1]

Perlite is mined at 13 sites in six western states, with 86 percent of the production coming from five mines in New Mexico.[2] Perlite expansion, on the other hand, is widely distributed throughout the United States; 80 plants are currently in operation, and these expansion plants are located in 33 states.[2] Four companies with 12 plants producing more than 18.2 Gg/year (20,000 tons/year) account for approximately 60 percent of the annual production of expanded perlite in the U.S. The remainder of the industry consists mainly of small independent operators producing less than 9.1 Gg/year (10,000 tons/year).[3]

The major pollutant from drying of crude perlite and from expanding and handling processes at expansion plants is particulate matter.

Test data are available on particulate emissions from dryers. There are little documented data for particulate emissions from expanding furnaces and none for fugitive particulate emissions from perlite handling.

While fabric filters are extensively used to control particulate emissions in all three areas, the degree of control might be increased from the present 98 percent to 99.5 percent under an NSPS. It is estimated that the impact of a standard, if promulgated, would be a reduction in particulate emissions of 92 Mg (101 tons) in 1985, distributed as follows (see Appendix A):

• Dryers	47 Mg (52 tons)
• Expanding furnaces	41 Mg (45 tons)
• Fugitive emissions	4 Mg (4 tons)

3.2 ISSUES

The mills which dry crude perlite are currently subject to the nonmetallic mineral processing standard which covers crushing, sizing, and material transport. Drying, which is not covered, occurs between two crushing processes that are covered. The control devices on dryers are often used to control emissions from crushing and other processes. The development of any standard for drying should, therefore, be coordinated with the nonmetallic mineral processing standard.

The expanding segment of the perlite industry consists mainly of small independent operations throughout the country. In 1978, there were 80 plants in 33 states with the typical plant consisting of one to two furnaces. The development of a standard would reduce particulate emissions 0.7 to 1.4 Mg/year (0.8 to 1.6 tons/year) for a typical new plant of one to two furnaces. This figure includes the reduction attributed to improved control of both furnace emissions and fugitive emissions. The development of a lower size cutoff exempting one furnace operation might drive the industry further toward small independent operations through the franchise systems that already exist.

Finally, there is a lack of test data to document the best controlled facilities and the degree of control which is achieved. Therefore, the potential impact of an NSPS is unclear, and the development of an NSPS would be costly -- essentially all the emissions data for expansion plants would have to be collected by stack sampling during the development of the standard.

3.3 RECOMMENDATIONS

It is recommended that no standard be developed for the perlite source category. The impact of a standard for a typical dryer and expanding plant (furnace and fugitive) would be a reduction in particulate emissions of 15.9 Mg/year (17.5 tons/year) and 0.7 to 1.4 Mg/year (0.7 to 0.8 tons/year), respectively. For the entire source category, the reduction would be only 92 Mg (101 tons) in 1985.

It is recommended, however, that development of a standard be considered for dryers at nonmetallic mineral mills. Of the 20 minerals subject to the nonmetallic mineral processing NSPS, 18 utilize dryers before processing is complete.[11] Regulatory efficiencies could accrue if the dryer standard were incorporated into the nonmetallic mineral processing standard.

4. DESCRIPTION OF INDUSTRY

4.1 SOURCE CATEGORY

Perlite is a glassy volcanic rock with an "onion skin" fracture. It is characterized by expansion up to 20 times its original volume when heated to a temperature within its softening range of 1033 to 1366K (1400° to 2000°F). Both perlite ore (crude perlite) and the expanded product (expanded perlite) are typically referred to by the collective term perlite. Commercial production of expanded perlite in the United States began in 1946, and the industry has grown steadily over the past 33 years.[1]

Expanded perlite has a variety of industrial and construction uses because of its (1) low bulk density, (2) low thermal conductivity, (3) high fire resistance, and (4) low sound transmission. Approximately 70 percent of the expanded product produced domestically is used in building construction components, such as plaster and concrete aggregates, loose-fill insulation, insulation board, and ceiling tile. Alternate materials which compete with perlite in the various use categories include vermiculite, expanded clay, shale and slag, volcanic cinders, foamed concrete, mineral wood, diatomite, asbestos, and plastic foams.[2]

Crude perlite is produced by 12 companies at 13 mines in six western states.[2] Total employment at mines and milling operations was 185 in

1978.[13] Grefco, Inc., Johns-Manville Corporation, and Silbrico Corporation are the largest producers of perlite ore in the U.S., accounting for approximately 80 percent of the total annual output.[14] New Mexico is the leading state in crude perlite production with 86 percent of the total ore mined in 1978.[2] Other producing states, in descending order, are Arizona, California, Idaho, Colorado, and Nevada. Domestic producers of crude perlite are listed in Table 4-1.

Table 4-1. DOMESTIC PRODUCERS OF CRUDE PERLITE[1]

State	Location	Company
New Mexico	Socorro No. Agua	Grefco, Inc.
New Mexico	No. Agua	Johns-Manville Corp.
New Mexico	No. Agua	Silbrico Corp.
New Mexico	No. Agua	U.S. Gypsum Company
Arizona	Superior	Filters International, Inc.
Arizona	Superior	Harborlite Corp.
Arizona	Superior	Guzman Construction Co.
California	Inyo County	American Perlite Corp.
Idaho	Malad City	Oneida Perlite Corp.
Colorado	Caliente	Delamor Perlite Co.
Colorado	Florence	Persolite Co.
Nevada	Lovelock	U.S. Gypsum Co.

Expanded perlite was produced at 80 plants located in 33 states during 1978.[2] For the most part, these plants were located near market areas. Total employment for expanding operations was less than 500 in 1979.[3] Four companies, Grefco, Inc., Johns-Manville Corporation, Silbrico Corporation, and Armstrong Cork Company, annually account for more than 60 percent of the expanded perlite manufactured in the U.S.[3] The remainder of the industry consists mainly of small, independent expanders producing less than 9.1 Gg (10,000 tons) yearly.[3] The three largest crude perlite producers (Grefco, Johns-Manville, and Silbrico) have instituted a franchise system that assures independent expanders of crude ore supplies, technical assistance, quality control specifications, marketing aids, national advertising, and product literature.[1] Table 4-2 lists the companies which expand perlite in the U.S., and Table 4-3 lists individual expanding plants by state.[1]

4.2 PRODUCTION AND DEMAND PROJECTIONS

The United States is the world's largest producer and consumer of perlite. According to the U.S. Bureau of Mines, production of crude perlite in 1978 was a record high 854 Gg (939,000 tons), an 8 percent increase over 1977.[2] 1978 was also a record year for expanded perlite production, with the 503 Gg (553,000 tons) produced representing a 10-percent increase over 1977.[2] Total value for crude and expanded perlite sales in 1978 was $13.7 million and $64.3 million, respectively.[1] Industry production figures are given in Table 4-4 for perlite ore mined and expanded perlite produced on an annual basis between 1969 and 1978.

Illinois continues to be the leading state in expanded perlite production. In 1977, the most recent year for which complete data are available, the largest producers of expanded perlite in descending order were Illinois, Mississippi, California, Virginia, Texas, Pennsylvania,

Table 4-2. DOMESTIC PRODUCERS OF EXPANDED PERLITE[1]

Company	Address
Airlite Processing Corp. of Florida	3505 65th St., Vero Beach, FL 32960
American Perlite Products, Inc.	Box 128, Gilliam, LA 71029
Armstrong Cork Co.	Lancaster Sq., Lancaster, PA 17604
Aztec Perlite Co.	1518 Simpson Way, Escondido, CA 92025
Brouk Company	1367 S. Kingshighway Blvd., St. Louis, MO 63110
Buffalo Perlite Div. of Pine Hill Concrete Mix Corp.	100 Sugg Rd., Buffalo, NY 14225
California Cement Shake Co., Inc.	5355 N. Vincent Ave., Irwindale, CA 91706
Carolina Perlite Co.	Box 158, Gold Hill, NC 28071
C-E Refractories	Port Kennedy, PA 19463
Chemrock Corp.	Box 7151, Nashville, TN 37210
Cleveland Gypsum Co.	2100 W. 3rd St., Cleveland, OH 44113
Filter Media, Inc.	Box 19156, Houston, TX 77024
Filter Products Corp.	124 N. Buesching Rd., Lake Zuric, IL 60047
Georgia-Pacific Corp.	900 S.W. 5th, Portland, OR
Grefco, Inc.	3450 Wilshire Blvd., Los Angeles, CA 90010
Harborlite Corp.	Box 458, Escondido, CA 92025
Johns-Manville Corp.	Ken-Caryl Ranch, Denver, CO
Lite Weight Products, Inc.	707 Funston Rd., Kansas City, KS 66115
Mica Pellets, Inc.	1120 Oak St., DeKalb, IL 60115
Midwest Perlite Co.	542 W. Lindberg, Appleton, WI 54911
National Gypsum Co.	325 Delaware Ave., Buffalo, NY 14202
Oneida Perlite Corp.	Box 162, Malad City, ID 83252
Pacific Coast Products	Box 360, Sebastopol, CA 95472
Pamrod Products	Box 335, McQueeney, TX 78123
Paramount Perlite Co., Inc.	Box 83, Paramount, CA 90723
Pennsylvania Perlite Corp.	Box 2002, Lehigh Valley, PA 18001
Perlite Mfg. Co.	Box 478, Carnegie, PA 15106
Perlite of Houston, Inc.	Box 8386, Houston, TX 77004
Perlite Popped Products	12655 E. Imperial Hwy, Santa Fe Springs, CA 90670
Persolite Products, Inc.	Box 105, Florence, CO 81226
Redco, Inc.	11831 Vose St., N. Hollywood, CA 91605
Scotlite International Corp.	35 Woodward Ave., Troy, NY 12180
Schundler Co.	Box 249, Metuchen, NJ 08840
Silbrico Corp.	6300 River Rd., Hodgkins, IL 60525
Sil-Flo, Inc.	Box 388, Port Jefferson, NY 11777
South Texas Perlite	Box 27272, San Antonio, TX 78227
Strong-Lite Products	Box 8068, Pine Bluff, AR 71611
Supreme Perlite Co.	4600 N. Suttle Rd., Portland, OR 97217
The Celotex Corp.	Box 22602, Tampa, FL 33622
The Pax Co.	580 W. 13th S., Salt Lake City, UT 84115
Thermo-O-Rock Div. of Allied Block Chemical Co.	Box 455, New Eagle, PA 15067
United States Gypsum Co.	101 S. Wacker Dr., Chicago, IL 60606
Whittemore Perlite Co., Inc.	Dundee Park, Andover, MA 01810
W. R. Grace & Co.	62 Whittemore Ave., Cambridge, MA 02140

Table 4-3. ACTIVE PERLITE EXPANDING PLANTS[15]
(As of December 30, 1978)

State	Plant location (nearest city)	Company
Arkansas	West Memphis	Temple Gypsum
	Pine Bluff	Strong-lite Products, Inc.
California	Escondido	Harborlite Corp.
	Paramount	Paramount Perlite Co.
	Santa Fe Springs	Perlite Popped Products
	North Hollywood	American Perlite, Inc. (Redco)
	Sebastapol	Scottlite Products
	Escondido	Aztec Perlite Co.
	Santa Fe Springs	Perlite Processing
Colorado	Antonito	Grefco, Inc.
	Florence	Persolite Products
Florida	Jacksonville	Chemrock Corp.
	Pompano	W. R. Grace
	Vero Beach	Airlite Processing Corp.
	Pensacola	Armstrong Cork Co.
Georgia	Macon	Armstrong Cork Co.
Idaho	Malad City	Oneida Perlite Corp.
Illinois	DeKalb	Mica Pellets, Inc.
	Hodgkins	Silbrico Corp.
	Waukegan	National Gypsum Co.
	Lake Zurich	Filter Products Corp.
	Joliet	Johns-Manville Corp.
Indiana	Lafayette	Chemrock Corp.
	Shoals	U.S. Gypsum Co.
	East Chicago	U.S. Gypsum Co.
	Shoals	National Gypsum Co.
	Vienna	Airlite Processing Corp.
	Crawfordsville	Grefco, Inc.
Iowa	Fort Dodge	National Gypsum Co.
	Fort Dodge	U.S. Gypsum Co.
Kansas	Kansas City	Lite Weight Products

Table 4-3. Continued

State	Plant location (nearest city)	Company
Kentucky	Wilder Florence	W. R. Grace Grefco, Inc.
Louisiana	Gilliam Reserve	American Perlite Products Filter-Media Co. of Louisiana
Maine	Rockland	Chemrock Corp.
Maryland	Baltimore	National Gypsum Co.
Massachusetts	Andover Boston	Whittemore Perlite Co. U.S. Gypsum Co.
Michigan	Vicksburg Detroit	Harborlite Corp. U.S. Gypsum Co.
Mississippi	Natchez	Johns-Manville Corp.
Missouri	St. Louis	Brouk Co.
Nevada	Empire	U.S. Gypsum Co.
New Hampshire	Portsmouth	National Gypsum Co.
New Jersey	Jamesburg Edison	Grefco, Inc. The Schundler Co.
New York	Oakfield Buffalo Buffalo Troy	U.S. Gypsum Co. National Gypsum Co. Buffalo Perlite Div. of Pinehill Concrete Mix Corp. Scotlite International Corp.
North Carolina	Gold Hill Randolf Co.	Carolina Perlite Co. W. R. Grace
Ohio	Gypsum Lorain Cleveland Lockland	U.S. Gypsum Co. National Gypsum Co. Cleveland Gypsum Co. THe Celotex Corp.
Oregon	Portland	Supreme Perlite Co.

Table 4-3. Concluded

State	Plant location (nearest city)	Company
Pennsylvania	Carnegie	Perlite Manufacturing Co.
	Philadelphia	U.S. Gypsum Co.
	Marietta	Armstrong Cork Co.
	Allentown	Pennsylvania Perlite Corp.
	York	Pennsylvania Perlite Corp. of York
Tennessee	Nashville	Chemrock Corp.
Texas	Dallas	W. R. Grace
	San Antontio	South Texas Perlite
	McQueeney	Pamrod Products
	Sweetwater	U.S. Gypsum Co.
	La Porte	Filter Media, Inc.
	Tomball	Perlite of Houston, Inc.
	Fort Worth	Sil-Flo, Inc.
Utah	Sigurd	Georgia-Pacific Corp.
	Salt Lake City	The Pax Company
	Selmore	Mountain Made Ute-Light Weight Products
Virginia	Woodstock	Johns-Manville Corp.
West Virginia	Keyser	American Mineral Ind.
Wisconsin	Appleton	Midwest Perlite Co.
	Milwaukee	W. R. Grace
Wyoming	Green River	Western Perlite Corp.

Table 4-4. CRUDE AND EXPANDED PERLITE PRODUCED IN THE UNITED STATES (1969-1978)[2]

Year	Crude perlite mined, Gg (tons x 10^3)	Expanded perlite produced, Gg (tons x 10^3)
1969	558 (613)	369 (405)
1970	552 (607)	382 (420)
1971	450 (495)	354 (389)
1972	591 (649)	389 (427)
1973	691 (759)	386 (424)
1974	618 (679)	385 (423)
1975	642 (706)	365 (401)
1976	662 (727)	399 (438)
1977	793 (871)	459 (504)
1978	854 (939)	503 (553)

Kentucky, Colorado, New Jersey, Florida, Indiana, and Ohio.[1] Leading states according to value of expanded product sold or used were, in descending order, Illinois, California, Kentucky, Texas, Pennsylvania, New Jersey, Mississippi, Virginia, Florida, and Colorado. A list of expanded perlite production by state for 1977 and 1978 is given in Table 4-5.

The domestic demand and production of perlite are predicted to rise steadily through the year 2000. Production of expanded perlite is expected to be on the order of 712 Gg (782,000 tons) in 1985 and 1.1 Tg (1.2×10^6 tons) in 2000. Table 4-6 summarizes projected domestic demand and production of expanded perlite in the United States for 1985 and 2000.[1]

No significant changes are currently projected for supply-demand relationships within the perlite industry in the United States. This is also true for other producing countries that have established perlite product and marketing areas. One factor that could affect the domestic perlite industry is the cost of transporting perlite ore from the western United States, where it is mined, to the eastern seaboard where large markets presently exist. If future transportation costs from foreign producers become less than shipping costs from New Mexico to the eastern states, then perlite imports in that region are a real possibility.[1] There is currently no tariff or special taxes applicable to perlite. A 10-percent depletion allowance is granted to perlite producers on foreign and domestic mining.

4.3 PROCESS DESCRIPTION

The perlite source category survey focuses on two separate processes within the industry, drying and expansion. As mentioned previously, dryers are an integral part of the milling operation, which usually occurs

Table 4-5. EXPANDED PERLITE PRODUCED IN THE UNITED STATES[2]

State	1977 Quantity produced, Mg (tons)		1978 Quantity produced, Mg (tons)	
Arkansas	546	(600)	364	(400)
California	37,765	(41,500)	35,854	(39,400)
Florida	24,934	(27,400)	25,662	(28,200)
Illinois	a		69,888	(76,800)
Indiana	18,018	(19,800)	16,926	(18,600)
Iowa	a		1,001	(1,100)
Kansas	910	(1,000)	a	
Maryland	a		--	
Massachusetts	a		2,639	(2,900)
Minnesota	--		a	
Nevada	a		455	(500)
New Hampshire	a		91	(100)
New York	5,733	(6,300)	a	
Ohio	11,648	(12,800)	a	
Pennsylvania	32,123	(35,300)	32,578	(35,800)
Texas	32,396	(35,600)	39,494	(43,400)
West Virginia	a		--	
Other States	290,290	(319,000)	277,550	(305,000)
Total[b]	458,640	(504,000)	503,230	(553,000)

[a]Withheld to avoid disclosing company proprietary data. Included with Other States.
[b]Data may not add to totals shown because of independent rounding.

Table 4-6. SUMMARY OF PROJECTED DOMESTIC PERLITE DEMAND AND PRODUCTION FOR 1985 AND 2000[1]

Year	Gg (ton x 10^3)	
	Demand[a]	Production[b]
1978	542 (596)	503 (553)
1985	664 (730)	712 (782)[c]
2000	1,089 (1,200)	1,095 (1,206)[c]

[a]Demand is the total quantity of crude perlite sold or used (approximately 8 percent is used in the unexpanded form and 92 percent is expanded).
[b]Production is the amount of crude perlite expanded.
[c]Probable value from Reference 1.

at the mine site. Expansion is a separate process that is frequently located several hundred to several thousand miles away.

Perlite is extracted using open pit mining techniques and then milled. Milling (crushing, drying, screening) is necessary prior to expansion in order to: (1) produce particles approximating a cubic shape -- primary crushing, (2) remove excess free moisture to facilitate sizing -- drying, (3) produce desired size gradations -- secondary crushing, and (4) provide for separation of specific particle sizes -- screening. Figure 4-1 shows a process flow diagram for a typical mining and milling operation.

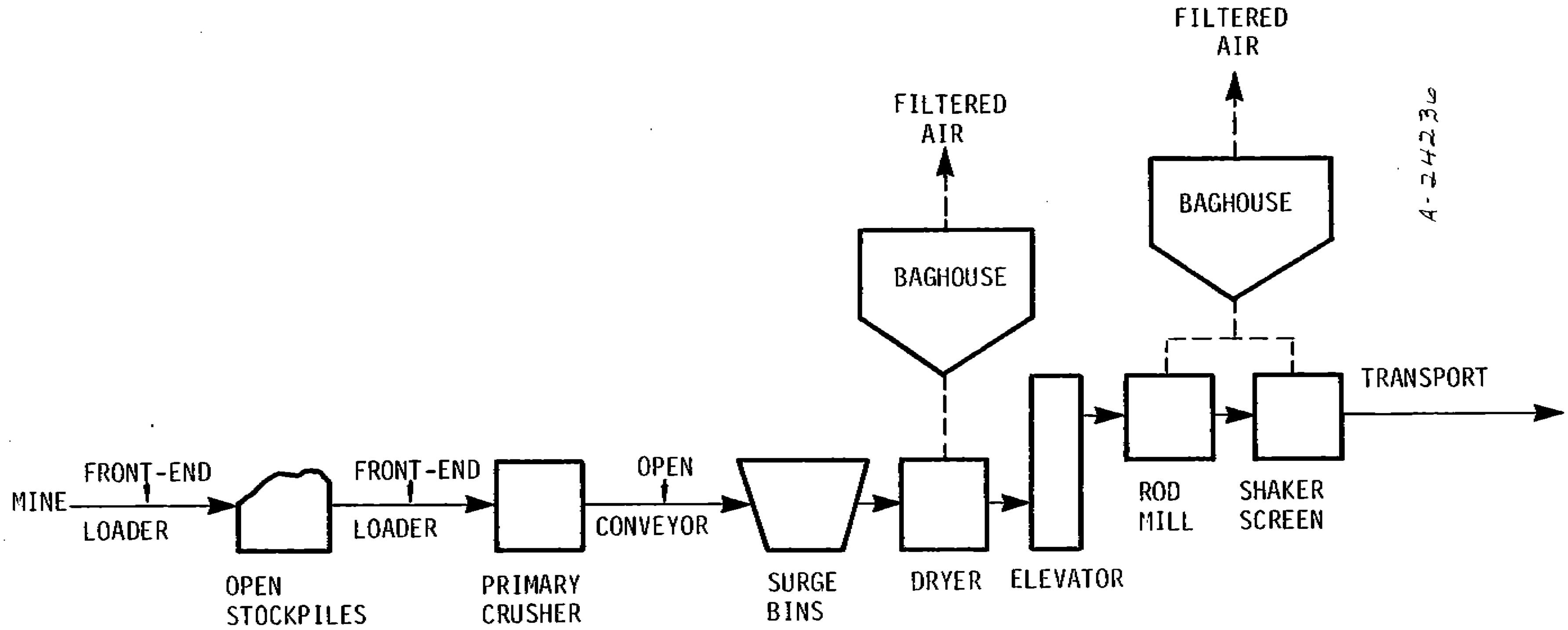

Figure 4-1. Flow diagram for a typical mining and milling operation.[16]

Rotary dryers are used to remove excess free moisture associated with perlite ore. Rotary dryers may be fired with either gas or oil. Figure 4-2 is a schematic of a direct rotary dryer.

Particulate emissions sources from perlite milling include ore loading and unloading, transport and conveying, crushing, drying, screening and storage. Only emissions from dryers are considered under the perlite source category. Other emission sources are included under the nonmetallic minerals processing source category.

After milling operations are complete, the crude perlite is ready for expansion. Because expanded or "popped" perlite is a frothy, low density material, milled crude perlite is commonly shipped to expanding plants located near major product use areas in order to reduce freight charges.

A typical perlite expanding plant consists of crude perlite unloading and storage facilities, an expanding furnace, a classifying and collection system for the product, and air pollution control equipment. Figure 4-3 is a flow diagram for a typical perlite expanding plant.

Perlite is expanded by injecting the crude material into a gas- or oil-fired furnace with a temperature between 1033 to 1366K (1400^{o} to 2000^{o}F).[1] The appropriate temperature for a particular feed size and composition is the point at which the processed perlite softens to a plastic state and the water of hydration is released as steam. The escape of the entrapped water causes the perlite particles to expand rapidly, up to 20 times their original volume. The product formed from this process is called expanded or "popped" perlite. Properties of the crude perlite being expanded, such as amount of entrapped water, the degree to which particles approximate a cubic shape, and size gradations, are important factors affecting the final product. Other parameters affecting the

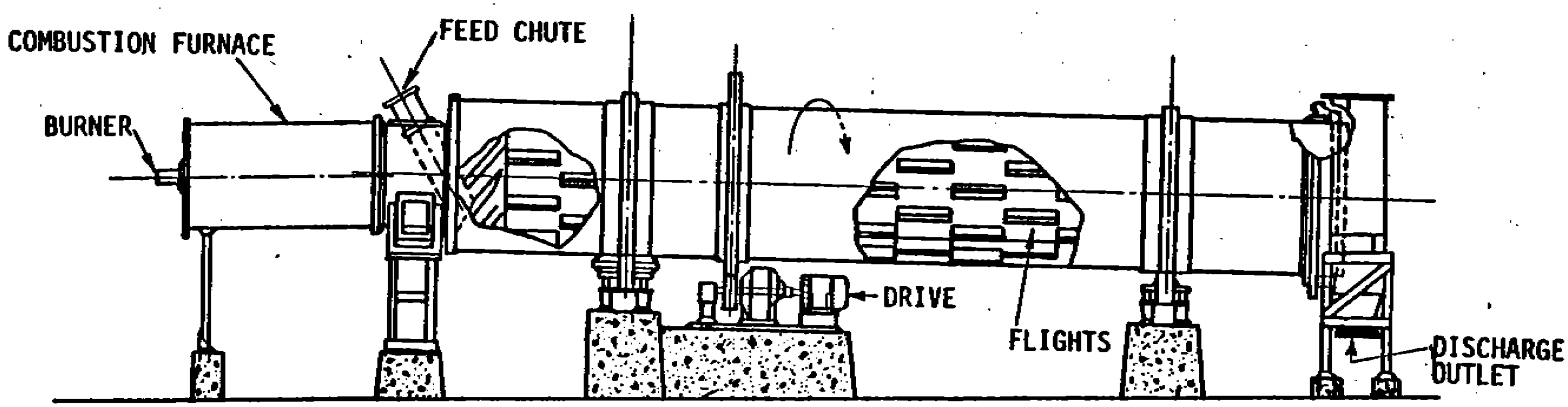

Figure 4-2. A typical direct-fired, cocurrent, rotary dryer.[17]

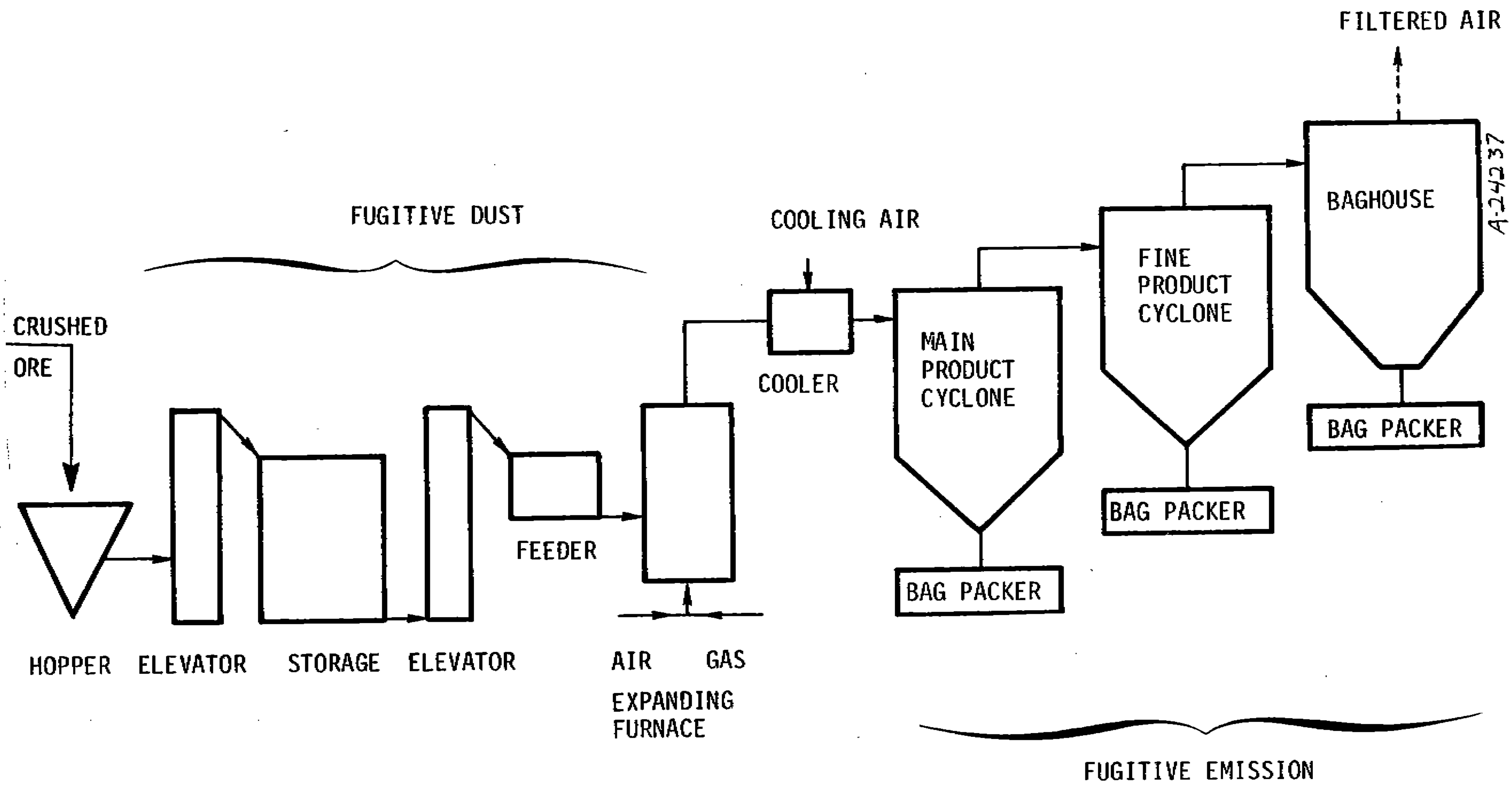

Figure 4-3. Flow diagram for a typical perlite expanding plant.

product quality and plant efficiency include the use of feed preheat, the rate of heat application during expansion, and the method of injecting the crude perlite into the expansion zone of the furnace.

Two types of furnaces are commonly used for expanding perlite, horizontal rotary and vertical furnaces. The horizontal rotary type furnace typically has a preheating shell around the direct-fired expanding tube. After preheating, the feed is introduced into the inner shell where it is exposed to the direct heat of the burner flame. An induced draft fan draws the particles out of the furnace and through the cyclone classifier and collection system.

A stationary vertical furnace consists of a steel tube insulated by either refractories or a shell providing air space around the furnace. Following optional preheating in a rotary heater, the feed is introduced into the furnace just above the flame. From this location near the bottom of the furnace, the expanded perlite is blown up the furnace by combustion product gases through the cyclone collection and then drawn through the sizing system by an induced draft fan. Figure 4-4 provides a sketch of a stationary vertical furnace.

At least two companies maintain mobile vertical furnaces which are transported to locations remote from expanding plants in order to produce expanded perlite on an ad hoc basis. The furnaces are set up for several days or weeks, depending on the specific requirement, and then dismantled and returned to the perlite expanding company. These mobile units include cyclones and baghouses as an integral part of the collection/classification system.

Particulate emissions (perlite particles) are released from expanding furnaces. Exhaust gases typically contain entrained perlite fines which

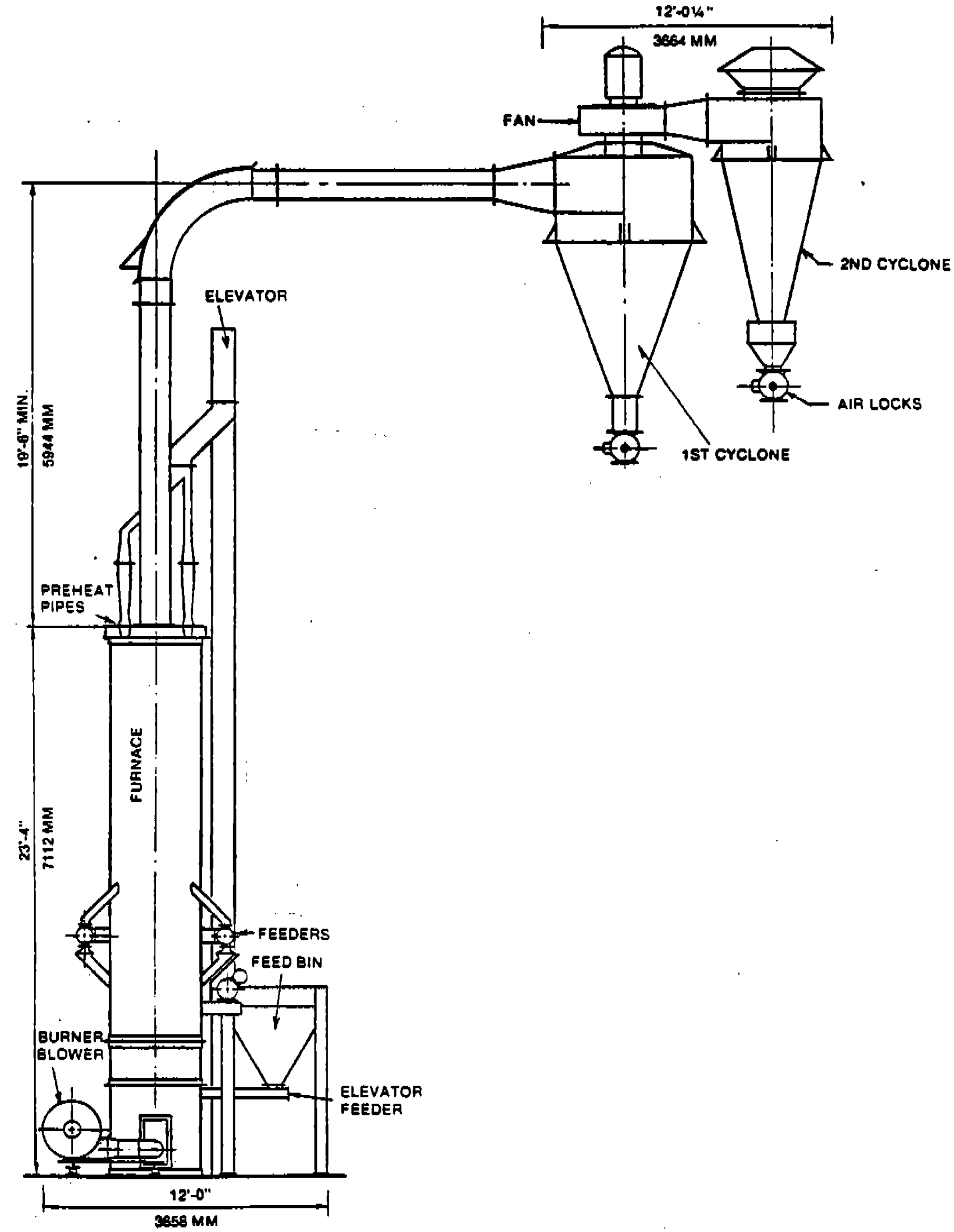

Figure 4-4. Typical stationary vertical expanding furnace and cyclone collection/classifying system.[8]

are not removed by the cyclone classifying/collection system. Exhaust gases go from the furnace through the cyclone/baghouse in a closed system, i.e., no emission points occur until the stack and bagging operation.

Fugitive emissions are potentially a significant source of airborne particulate matter from perlite expanding plants. Perlite dust may be released to the atmosphere from such diverse sources as loading and unloading operations, materials handling, storage, transfer and conveying, and product bagging.

5. AIR EMISSIONS

This chapter identifies the types and quantities of air pollutants from specific sources within the perlite industry. Particulate matter (perlite fines) is the major air pollutant released during the drying and expansion of crude perlite. In addition, oxides of nitrogen and oxides of sulfur are emitted from gas- and oil-fired dryers and furnaces.

5.1 PLANT AND PROCESS EMISSIONS

5.1.1 Particulate Emissions

Particulates are discharged through stacks from perlite dryers and expanding furnaces and released as fugitive emissions from material handling at expansion plants. The vast majority of these emissions result from perlite fines entrained in exhaust gases. Since natural gas and distillate oil are the only fuels used, only minor amounts of combustion-derived particulates are emitted.

Exhaust gases from perlite dryers contain fine particles produced during initial crushing. As the crushed ore is heated to approximately 366K (200°F)[18] in the dryer, particulate matter becomes entrained in the heated air. The amount and size distribution of particulate emissions are affected by variables such as quantity of fines produced during crushing, temperature, and residence time. Little data exist to delineate the size and density of particles from perlite dryers; however, in at least one case more than 98 percent of the baghouse catch was less than 400 mesh.[17]

Emission factors have not been established for particulates from perlite dryers. Similiar type and size dryers are used in the phosphate rock industry, and the exhaust gas characteristics from these dryers have been studied. The upper limit uncontrolled emission rate developed for phosphate rock dryers is 9 kg/Mg (18 lb/ton).[4] This value was used to estimate uncontrolled particulate emissions from perlite dryers.

Expansion furnaces are also significant sources of perlite particulate emissions. Expanded product and waste fines are discharged from the expansion process at relatively high temperatures 1033K (1400^{o}F). Size and weight distribution of particulate emissions, as well as amounts, are influenced by factors such as desired product, input crude size, temperature, residence time, and air-fuel ratio.

Particulate emission factors for vertical expansion furnaces without controls are 10.5 kg/Mg (21 lb/ton).[5] Industry personnel indicate that this emission factor is reasonable and although it varies with both furnace type and product density, is representative of the industry as a whole.[9]

Because no emission factors have been developed for perlite fugitive emissions, it is necessary to extrapolate from the values developed for similar processes. Table 5-1 summarizes uncontrolled emissions for ore loading, transfer and conveying, and storage from the rock and phosphate rock industries.[6] No data are available on particulate emissions from expanded product bagging operations.

Table 5-1. POTENTIAL FUGITIVE PARTICULATE EMISSIONS (PFPE) IN MATERIAL BENEFICIATION[5]

Source of PFPE	Range of uncontrolled fugitive emission factors	Emission factors by industry kg/Mg (lb/ton)	
		Rock	P_2O_5 rock
Ore loading	Negligible -- 0.05 kg/Mg (0.10 lb/ton) of ore	0.025 (0.05)	NA
Transfer and conveying	Negligible -- 0.75 kg/Mg (1.5 lb/ton) of ore	NA	0.75 (1.5)
Storage	0.0118 -- 0.2 kg/Mg (0.0235-0.42 lb/ton)	0.165 (0.33)	0.10 (0.20)

NA -- not available

Table 5-2 summarizes estimated particulate emissions from a typical perlite dryer and expanding facility using the emission factor discussed above.

Uncontrolled and controlled emissions are presented, with the controlled rates assumed to be the allowable limits in a typical SIP (see Chapter 8).

5.1.2 Nitrogen Oxides Emissions

Perlite drying and expanding processes normally emit negligible quantities of NO_x. In the case of perlite dryers, relatively low temperatures and the use of low nitrogen fuels minimize both thermal and fuel NO_x. Expanding furnaces also utilize low nitrogen fuels. The relatively high furnace temperatures, however, may cause some NO_x formation. Since none of the states contacted considered NO_x emissions from perlite expanding plants a problem at the present time, no data are available for this pollutant.

5.1.3 Sulfur Oxides Emissions

Sulfur oxide emissions are due to the combustion of sulfur containing fuels. Natural gas, the most common fuel type used by the perlite industry for both dryers and expanding furnaces, is not a significant source of SO_2 emissions. Distillate oil is used in some instances, especially for dryers, and may result in SO_2 emissions due to sulfur content. No data on SO_2 emissions from perlite dryers or expanding furnaces are available, and it is not known how much, if any, of the sulfur is adsorbed on the perlite particles.

5.1.4 Other Criteria Pollutants

There are no data available to indicate that air emissions from perlite processing operations include significant quantities of hydrocarbons, carbon monoxide, or lead.

Table 5-2. ESTIMATED PARTICULATE EMISSIONS FROM A TYPICAL PERLITE DRYER AND EXPANDING PLANT

	Typical production rate				Uncontrolled particulate emissions				Controlled particulate emissions			
	Mg/h	tons/hr	Mg/yr[a]	tons/yr[a]	kg/Mg	lb/ton	Mg/yr[a]	tons/yr[a]	kg/Mg	lb/ton	Mg/yr[a]	tons/yr[a]
Dryer (horizontal rotary)	27	30	113,000	125,000	9[b]	18[b]	1017	1125	0.2[e]	0.4[e]	20.3	22.5
Expanding furnace (vertical or horizontal)	0.9	1	3,777[b]	4,160	10.5[c]	21[c]	40	44	0.2[f]	0.4[f]	0.8	0.8
Fugitive from expanding plant (ore loading, transfer and conveying storage)	0.9	1	3,777[b]	4,160	0.94[d]	1.88[d]	4	4	0.2[f]	0.4[f]	0.8	0.8

[a]Assume 16 hr/day, 5 days/wk, 52 wk/yr.
[b]From Reference 4.
[c]From Reference 5.
[d]Summation of emission factors for (1) ore loading, (2) transfer and conveying and (3) storage from Reference 6.
[e]From emissions (stack) tests on dryer.
[f]Assumes baghouse operating at 98 percent collection efficiency.

5.1.5 Hazardous Pollutants

Perlite is a relatively inert material, considered a nuisance dust in the working environment. Recent health effects studies on workers in the perlite industry suggest that exposure to perlite dust for periods of as long as 20 years has negligible effect on lung function.[19,20] At the present time there is no evidence available to indicate that a perlite National Emission Standards for Hazardous Air Pollutants should be developed.

5.2 TOTAL NATIONAL PARTICULATE EMISSIONS

Current nationwide estimates of particulate emissions for perlite dryers, expanding furnaces, and fugitive emissions from expansion plants are given in Table 5-3. Production figures for 1978 were obtained from the U.S. Bureau of Mines, and information on control technology utilized within the industry was taken from communications with the Perlite Institute, Inc., industry personnel, state agencies, and individual perlite companies.

Table 5-3. TOTAL NATIONAL APRTICULATE EMISSIONS FOR PERLITE DRYERS AND EXPANDING FURNACES (1978)

Process	Production[a]		Uncontrolled emission factors		Control technology collection efficiency, %	Emissions	
	Mg/yr	tons/yr	kg/Mg	lb/ton		Mg/yr	tons/yr
Dryers (horizontal rotary)	854,000	939,000	9[b]	18[b]	98	154	169
Expanding furnaces (vertical and horizontal)	503,000	553,000	10.5[c]	21[c]	98	106	116
Fugitive (at expanding plant)	503,000	553,000	0.94[d]	1.88[d]	98[e]	241	265
Totals						501	550

[a]From Reference 1.
[b]From Reference 4.
[c]From Reference 5.
[d]From Reference 6.
[e]Assume 50 percent of fugitive emissions are controlled to 98 percent efficiency and 50 percent uncontrolled.

6. CONTROL TECHNOLOGY

6.1 CURRENT CONTROL TECHNOLOGY

The control technology utilized by the perlite industry to reduce particulate emissions from dryers is primarily fabric filters (baghouses). While processing schemes vary from mill to mill, the larger milling operations generally employ a separate baghouse to control emissions from the dryers. Smaller operators may utilize a common baghouse to collect particulates from screening, crushing, and ore handling, as well as drying operations. There is no common design for baghouses used at mills as they are frequently surplus equipment rather than custom designed. The baghouses that are used employ air-to-cloth ratios from 0.6:1 m/min (2.0:1 ft/min) to 1.4:1 m/min (4.5:1 ft/min).[18,21,22] Cleaning mechanisms vary from pulse jet every 12 seconds to mechanical shaking keyed to pressure drop. Acrylic felt and nomex as well as cotton are reportedly used as bag materials.

Fabric filters are also the primary type of control technology utilized to control particulate emissions from expanding furnaces. While cyclones are an integral part of the product collection and sizing system attached to expansion furnaces, they do not provide the level of control necessary to meet existing regulations. Approximately 90 percent of domestic perlite expanding plants employ fabric filters for final particulate control. Furnace manufacturers, such as The Perlite Corporation, presently sell furnace-cyclone-baghouse units.

Fabric filters may be used to reduce particulate emissions from material handling. In several of the larger plants, perlite dust from loading and unloading, transfer and conveying, storage, and product bagging is passed through a baghouse prior to release to the atmosphere. In some instances, exhaust gases from the expanding furnace and fugitive emissions from material handling are vented through the same baghouse.

Perlite drying and expanding processes require that operators with baghouses pay attention to maintenance and baghouse temperature control. Because perlite particles are abrasive, they cause equipment erosion and reduced bag life. Unless proper inspection and maintenance procedures are followed, the filtering efficiency can be significantly impaired. Baghouse temperature control is needed to keep the temperature of the gases entering the baghouse within a specific range of 394 to 450K (250° to 350°F)[9] in order to prevent condensation and at the same time avoid burning up the bags.

Since the majority of perlite milling operations are located in regions with severe winters, ambient subzero temperatures are common for several months each year. In the case of exhaust gases from rotary dryers, it is often necessary during severe winter weather conditions to raise the temperature of the gas stream with auxiliary heaters before it enters the baghouse to prevent condensation.

Combustion gases from expansion plants present the opposite problem, since they are at relatively high temperature. Often combustion gases must be cooled several hundred degrees prior to entering the baghouse due to the temperature limitations of the fabric material. Cooling is generally accomplished by some combination of heat-exchangers, cooling within the collection cyclones, and dilution with ambient air.

6.2 ALTERNATIVE CONTROL TECHNIQUES

Wet-scrubbers are used at both milling and expanding plants to control particulate emissions. Only one small milling operation (less than 1 percent of total crude production) currently uses a wet-scrubber whereas five expanding plants, 154 Gg/yr (170,000 tons/year),[3] use scrubbers to control particulate emissions. Plant personnel estimate that the scrubbers operate at 98 percent collection efficiency and are sufficient to meet the applicable state regulations.[3]

6.3 BEST SYSTEMS OF EMISSION REDUCTION

Based on available information, fabric filters represent the best system of emission reduction for the perlite industry. The few scrubbers utilized today are holdovers from older plants. All of the people contacted felt that a new plant built anywhere in the country would utilize a fabric filter to control particulates from drying, expanding, and material handling operations.

7. EMISSIONS DATA

7.1 TEST DATA

Relatively few emission measurements are available for perlite drying and expanding operations. Some stack testing has been done to establish compliance status with respect to applicable control regulations, but in most cases visible emission or opacity readings are the primary method used to monitor compliance. This chapter summarizes the test methods employed.

7.1.1 Dryers

Table 7-1 presents the results of emissions tests conducted at four perlite dryers in New Mexico.[7] Approximately 75 percent of the domestic crude perlite production is dried at these four sites. The results for company A include fugitive emissions, whereas the results for company D indicate noncompliance with regulations. The average emissions 0.18 kg/Mg (0.37 lb/ton) for companies B and C is indicative of the emission rate for a dryer operating in compliance with current SIP's.

7.1.2 Expanding Plants

Few documented particulate emission tests have been performed on perlite expanding plants. In most cases, installation of a fabric filter baghouse has been considered sufficient to meet state regulations. To establish compliance, state regulatory personnel have frequently estimated

Table 7-1. EMISSIONS DATA FOR PERLITE DRYERS

Company	Equipment sampled	Test[c] method	Process rate		Allowable emission rate[a]		Measured emission rate			Apparent collection efficiency[b]
			Mg/h	tons/hr	kg/h	lb/hr	kg/h	lb/hr	lb/ton	%
A	Mill and dryer baghouse	EPA Method 5	40	44	15	33	11	25	0.57	97
B	Dryer baghouse	EPA Method 5	45	50	15	33	4	9	0.18	99
C	Dryer baghouse	EPA Method 5	23	25	14	31	6	14	0.56	97
D	Dryer baghouse	EPA Method 5	25	27	15	32	16	35	1.30	93

[a]Regulation 505, Section A, New Mexico.
[b]Calculated using the uncontrolled emission factor of 9 kg/Mg (18 lb/ton) from Reference 4.
[c]EPA Method 5 not confirmed.

particulate emissions for the appropriate process rate (10.5 kg/Mg, or 21 lb/ton from AP-42) and then assumed a reduction in these emissions proportional to the collection efficiency of the baghouse (96 to 99 percent). Visible emissions or opacity readings are then performed periodically to ensure that the baghouse is being properly maintained. Table 7-2 summarizes the applicable compliance testing methods for expansion plants reported to Acurex by individual states.

State agencies were unanimous in assuming that a well maintained baghouse will allow perlite expanding plants to meet existing control regulations.[12] Because baghouses are considered to be adequate control measures to meet existing regulations and because most perlite expanders are small, there has been little or no impetus to test these facilities. Table 7-3 summarizes emission test results obtained from the survey of state regulatory agencies.

7.2 EMISSIONS TESTS

The emissions tests done by local and state agencies have been performed according to standard EPA methods and guidelines. No problems unique to the perlite industry have been encountered. If additional testing were to be performed for the development of a standard, it is anticipated that EPA methods can be used without any special requirements other than the installation of sampling ports and platforms.

Table 7-2. COMPLIANCE TESTING METHODS FOR PERLITE PLANTS REPORTED BY INDIVIDUAL STATES[12]

State	Compliance test method
Arkansas	Unknown
So. (San Diego) California	VE
Los Angeles, California	VE/stack test
Colorado	VE
Florida	Unknown
Georgia	Unknown
Idaho	Stack sampling and data submitted by plant
Illinois	Check efficiency rate of baghouse and accept data submitted by plant
Indiana	VE
Iowa	VE and stack testing
Kansas	Unknown
Kentucky	Unknown
Louisiana	VE
Maine	
Maryland	Unknown
Massachusetts	Unknown
Michigan	Unknown
Mississippi	Stack test
Missouri	Unknown
Nevada	Unknown
New Hampshire	Stack test
New Jersey	Stack test
New York	Unknown
North Carolina	VE
Ohio	Unknown
Oregon	VE
Pennsylvania	Unknown
Tennessee	Data from source
Texas	VE/stack test/ambient monit.
Utah	VE/stack test
Virginia	Unknown
W. Virginia	Unknown
Wisconson	Unknown
Wyoming	Unknown

[a]Visible emissions

Table 7-3. PARTICULATE EMISSIONS FROM PERLITE EXPANDING PLANTS[3]

Company	Equipment sampled	Test[9] method	Process rate		Allowable emission rate[a]		Measured emission rate		Apparent collection efficiency[b]
			Mg/h	tons/hr	kg/h	lb/hr	kg/h	lb/hr	%
A	Wet scrubber on expanding furnace	EPA Method 5	4.8	5.25	6.7	14.8	7.0	15.5	86
B	Baghouse on expanding furnace	EPA Method 5	~0.8	~0.9	1.8	3.87	<1.8	<4	80
C	Wet scrubber on expanding furnace	EPA Method 5	5.9	6.5	6	14	1.4	3	98

[a]EDA Method 5 not confirmed.
[b]Using emission factors in Table 5-2.

8. STATE AND LOCAL EMISSIONS REGULATIONS

The state and local emissions regulations that are appropriate for perlite drying and expansion are those for visible emissions and particulates. Five of the six states in which perlite is dried use a Process Weight Rate Table to determine an acceptable rate of particulate emissions. The allowable emission rates for perlite drying processes are shown in Table 8-1. The typical emission limit is 14.1 kg/h (31 lb/hr) for a process flow of 27.2 Mg/h (30 tons/hr). This limit, however, is a plant-wide emission limit and includes all sources of particulate emissions at the mill, crushing, screening, fugitive, as well as drying emissions.

For expanding plants, as shown in Table 8-2, most states (22 of 33) allow approximately 1.86 kg (4.1 pounds) of emissions per hour for 0.9 Mg (1 ton) of processed material. Several states, however, require new plants to meet a 1.63 kg/h (3.6 lb/hr) limit while allowing existing plants to meet a 1.86 kg/h (4.1 lb/hr) rate. These emission limits apply to the entire plant and include both furnace and fugitive emissions.

Visible emissions standards apply to the perlite expansion industry in 32 of the 35 affected states (as shown in Tables 8-1 and 8-2). Ringlemann Number 1 or 20 percent opacity, which is equivalent, is the maximum allowable discharge for industrial processes in 18 of the

Table 8-1. STATE AND LOCAL REGULATIONS FOR PERLITE MILLS (Includes Dryers)

State	Regulation	Regulation no.	Valid for	Process weight rate limits @ 27.2 Mg/h (30 tons/hr)	Opacity limits, %
Arizona	Particulates/Process Weight Rate Table	R9-3-305A	Existing source	18.2 kg/h (40.0 lb/hr)	
Phoenix -- Tuscon Air Qual. Control Region	Particulates/Process Weight Rate Table	R9-3-305B	Existing source	13.4 kg/h (29.6 lb/hr)	
California					
Great Basin	Visible Emissions, Particulates, and Process	4049		18.2 kg/h (40.0 lb/hr and 0.79/nm^3 (0.3 gr/dscf)	20
Colorado	Visible Emissions	Reg. 1, Section 1	Existing		20
	Particulates/Process Weight Rate Table	Reg. 1, Section 2	Existing	13.4 kg/h (29.6 lb/hr)	
Idaho[b]	Visible Emissions Visible Emissions	1-1202 1-1203	Existing New		40 20
	Particulates/Process Weight Rate Table	1-1327-1328	Existing	18.2 kg/h (40.0 lb/hr)	
Nevada	Visible Emissions	Article 4	Existing		
	Particulates/Process Process Weight Rate Table	Article 7	Existing	9.7 kg/h (21.4 lb/hr)	
New Mexico	Visible Emissions	401	Existing		20
	Particulates -- Pumice, Mica and Perlite Process Equipment	505	Existing	14.1 kg/h (31.0 lb/hr)	

[a]27.3 Mg/h (1 ton/hr) is a typical process weight rate for a perlite mill.
[b]Idaho -- New state regulations are planned.
Tightening up of Process Weight Rate Table and Visible Emissions.

Table 8-2. STATE AND LOCAL REGULATIONS FOR PERLITE EXPANSION PLANTS

State	Regulation	Regulation no.	Valid for	Process weight rate limits @ 0.9 Mg/h (1 ton/hr)	Opacity limits, %
Arkansas	Particulates/Process Weight Rate Table	Subsection 8	Only Temple Gypsum at West Memphis, Arkansas	54 kg/h (120 lb/hr)	
California					
SCAQMD[b]	Visible Emissions, Particulates, and Process Weight Rate Table	405	Existing	1.7 kg/h (3.7 lb/hr)	20
Colorado	Visible Emissions	Reg. 1, Section 1	Existing		20
	Particulates/Process Weight Rate Table	Reg. 1, Section 2	Existing	1.63 kg/h (3.59 lb/hr)	
Florida	Visible Emisions, Particulates, and Process Weight Rate Table	17-2.05	New and existing	1.63 kg/h (3.59 lb/hr)	20
Georgia	Visible Emissions	391-3-1-0.02(2)(b)	Existing		40
	Particulates/Process Weight Rate Table	391-3-1-0.02(2)(e)	New and existing	1.86 kg/h (4.10 lb/hr)	
Idaho[c]	Visible Emissions	1-1202	Existing		40
	Visible Emissions	1-1203	New		20
	Particulates/Process Weight Rate Table	1-1327-1328	Existing	1.86 kg/h (4.10 lb/hr)	

[a]0.9 Mg/h (1 ton/hr) is a typical process weight rate for a perlite expansion plant.
[b]South Coast Air Quality Management District.
[c]Idaho -- New state regulations are planned.
Tightening up of Process Weight Rate Table and Visible Emissions.

Table 8-2. Continued

State	Regulation	Regulation no.	Valid for	Process weight rate limits @ 0.9 Mg/h (1 ton/hr)	Opacity limits, %
Illinois	Visible Emissions	202(b)	Existing		30
	Particulates/Process Weight Rate Table	203(a)	New	1.18 kg/h (2.60 lb/hr)	
	Particulates/Process Weight Rate Table	203(b)	Existing	1.86 kg/h (4.10 lb/hr)	
Indiana	Visible Emissions	APC-3(1)	Existing		40
Nonattainment areas	Visible Emissions	APC-3(2)	Existing		30
	Particulates/Process Weight Rate Table	APC-5	New and Existing	1.86 kg/h (4.10 lb/hr)	
Nonattainment areas	Particulates	APC-23	Existing		
Iowa	Particulates/Process Weight Rate Table	4.3(2)a	Existing	1.86 kg/h (4.10 lb/hr)	
Kansas	Particulates/Process Weight Rate Table	28-19-20	Existing	1.86 kg/h (4.10 lb/hr)	
	Visible Emissions	28-19-50A	Existing		40
	Visible Emissions	28-19-50B	New		20
Kentucky	Visible Emissions, Particulates, and Process Weight Rate Table	401 KAR 59:010	New	1.63 kg/h (3.59 lb/hr)	20
	Visible Emissions, Particulates, and Process Weight Rate Table	401 KAR 61:020	Existing	1.86 kg/h (4.10 lb/hr)	40

Table 8-2. Continued

State	Regulation	Regulation no.	Valid for	Process weight rate limits @ 0.9 Mg/h (1 ton/hr)	Opacity limits, %
<u>Louisiana</u>	Visible Emissions	18	Existing		20
	Particulates/Process Weight Rate Table	19	Existing	1.86 kg/h (4.10 lb/hr)	
<u>Maine</u>	Visible Emissions	598	New and existing		40
	Particulates/Process Weight Rate Table	602	New and existing	1.63 kg/h (3.59 lb/hr)	
<u>Maryland</u>	Visible Emissions	10.18.02,03,06,07	Existing		20
	Particulates/Process Weight Rate Table	10.18.02,03,06,07	Existing	1.88 kg/h (4.14 lb/hr)	
Washington Metropolitan Area	Visible Emissions	10.18.05.02	Existing		
	Particulates	10.18.05.03	Existing		
Baltimore Metropolitan Area	Visible Emissions	10.18.04.02	Existing		
	Particulates	10.18.04.03	Existing		
<u>Massachusetts</u>	Particulates/Process Weight Rate Table	7.02U(10)	Existing	1.88 kg/h (4.14 lb/hr)	
	Particulates/Process Weight Rate Table	7.02U(10)	New	0.94 kg/h (2.07 lb/hr)	
Critical area	Particulates/Process Weight Rate Table	7.02U(10)	Existing	0.94 kg/h (2.07 lb/hr)	
	Visible Emissions	7.06U(1)	Existing		20
<u>Michigan</u>	Visible Emissions	R336.41	Existing		20
	Particulates/Process Weight Rate Table	R336.44	Existing	1.88 kg/h (4.10 lb/hr)	

Table 8-2. Continued

State	Regulation	Regulation no.	Valid for	Process weight rate limits @ 0.9 Mg/h (1 ton/hr)	Opacity limits, %
Mississippi	Visible Emissions	Section 3	Existing		40
	Particulates/Process Weight Rate Table	Section 3	Existing	1.88 kg/h (4.10 lb/hr)	
Missouri	Particulates/Process Weight Rate Table	10CSR 10-3.050	New and existing	1.88 kg/h (4.10 lb/hr)	
	Visible Emissions	10CSR 10-3.080	New and existing		20
Nevada	Visible Emissions	Article 4	Existing		
	Particulates/Process Process Weight Rate Table	Article 7	Existing	1.43 kg/h (3.14 lb/hr)	
New Hampshire	Visible Emissions	Reg. 17, Sec. III	New and existing		20
	Particulates/Process Weight Rate Table	Reg. 17, Sec. III	New	1.88 kg/h (4.10 lb/hr)	
	Particulates/Process Weight Rate Table	Reg. 17, Sec. III	Existing	2.29 kg/h (5.05 lb/hr)	
New Jersey	Visible Emissions, Particulates, and Process Weight Rate Table	Subchapter 6	New and existing	9.08 kg/h (20 lb/hr)	20
New York	Visible Emissions, Particulates, and Process Weight Rate Table	212	New and existing	1.78 kg/h (3.91 lb/hr)	20

Table 8-2. Continued

State	Regulation	Regulation no.	Valid for	Process weight rate limits @ 0.9 Mg/h (1 ton/hr)	Opacity limits, %
North Carolina	Particulates, $SO_{(2)}$ from Light-Weight Aggregate Processes	0.0511	Existing		
	Particulates/Process Weight Rate Table	0.515	Existing	1.88 kg/h (4.10 lb/hr)	
	Visible Emissions	0.0521	Existing		40
Ohio	Visible Emissions	3745-17-07	Existing		20
	Particulates/Process Weight Rate Table	3745-17-11	Existing	1.88 kg/h (4.10 lb/hr)	
Oregon	Visible Emissions	21-015	Existing		40
	Particulates/Process Weight Rate Table	21-045	Existing	1.88 kg/h (4.10 lb/hr)	
Pennsylvania	Particulates/Process Weight Rate Table	123.13	Existing	9 kg/h (19 lb/hr)	
	Visible Emissions	123.41	Existing		20
Tennessee	Visible Emissions	1200-3-5	Existing		20
	Particulates/Process Weight Rate Table	1200-3-7	Existing	1.88 kg/h (4.10 lb/hr)	
	Particulates/Process Weight Rate Table	1200-3-7	New	1.63 kg/h (3.59 lb/hr)	
Texas	Visible Emissions	Reg. 1, Section 131.03.03	Existing		30
	Particulates/Process Weight Rate Table	Reg. 1, Section 131.03.05	Existing	2.4 kg/h (5.3 lb/hr)	

Table 8-2. Concluded

State	Regulation	Regulation no.	Valid for	Process weight rate limits @ 0.9 Mg/h (1 ton/hr)	Opacity limits, %
Utah	Visible Emissions	Part II, Sec. 2.2	New and existing		40
Nonattainment[d]	Particulates	Part II, Sec. 2.3	Existing		
Virginia					
All ACQR's	Visible Emissions	4.22	Existing		20
ACQR 1-6	Particulates/Process Weight Rate Table	4.40A	Existing	1.88 kg/h (4.10 lb/hr)	
ACQR 7	Particulates/Process Weight Rate Table	4.40B	Existing	1.88 kg/h (4.14 lb/hr)	
West Virginia	Visible Emissions	Reg. 7, Section 2	Existing		20
	Particulates/Process Weight Rate Table	Reg. 7, Section 3	Existing	1.1 kg/h (2.4 lb/hr)	
Wisconsin	Particulates/Process Weight Rate Table	NR 154.11(3)	Existing	1.63 kg/h (3.59 lb/hr)	
	Visible Emissions	NR 154.11(6)	Existing		20
Wyoming	Visible Emissions, Particulates, and Process Weight Rate Table	Section 14	Existing	1.88 kg/h (4.10 lb/hr)	40
	Visible Emissions, Particulates, and Process Weight Rate Table	Section 14	New	1.63 kg/h (3.59 lb/hr)	20

[d]The EPA has not accepted the SIP for nonattainment areas. A new plant wanting to operate in a nonattainment area would be governed by existing Federal regulations.

35 states, but 11 states allow a greater discharge level of Number 2 (or 40 percent opacity). Most state regulations provide for exceptions to the limitations for short periods of time during startup or malfunction.

Because the perlite expansion industry is relatively small in most states, stack tests to determine compliance are not generally used. A visible emissions test of the source is the most common method of compliance determination employed by state and local agencies.

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APPENDIX A

To estimate the impact of an NSPS, the methodology referred to as "Model IV" was utilized.[23] The fundamental prioritization parameter $(T_s - T_n)$ was calculated.

Definitions:

T_s = total emissions under regulations existing in the baseline year

T_n = total emissions under an NSPS in the baseline year

$$(T_s - T_n) = K\ (B+C)(Es-En) \qquad (1)$$

where

K = Fractional utilization of existing industry capacity

B = Production capacity from construction and modification to replace obsolete facilities

C = Production capacity from construction and modification to increase output above baseline year capacity

E_s = Allowable emissions under existing regulations

E_n = Allowable emissions under an NSPS

and

$$B = A\ i\ P_B \qquad (2)$$

$$C = A\ i\ P_C \qquad (3)$$

where

A = Baseline year production capacity

P_B = Construction and modification rate to replace obsolete facilities

P_C = Construction and modification rate to increase industry capacity

i = Elapsed time in years

Table A-1. PRIORITIZATION PARAMETERS

	Dryers	Expanding furnaces	Fugitive emissions
K	0.82	0.82	0.82
A	854,000 Mg (939,000 tons)	503,000 Mg (553,000 tons)	503,000 Mg (553,000 tons)
B	173,000 Mg (191,000 tons)	102,000 Mg (112,000 tons)	102,000 Mg (112,000 tons)
C	273,000 Mg (261,000 tons)	208,000 Mg (229,000 tons)	208,000 Mg (229,000 tons)
E_S	0.185 kg/Mg (0.37 lb/tons)	0.21 kg/Mg (0.42 lb/tons)	0.02 kg/Mg (0.04 lb/tons)
E_n	0.045 kg/Mg (0.09 lb/tons)	0.05 kg/Mg (0.10 lb/tons)	0.005 kg/Mg (0.01 lb/tons)
P_B	2.9%	2.9%	2.9%
P_C	4.0%	5.9%	5.9%
i	7 years	7 years	7 years

Substituting the appropriate values for 1985 into Equation 1:

Dryers: $T_s - T_n = (0.82)(173,000 + 237,000)(0.185 - 0.045) = 47.1$ Mg

Expanding Furnaces: $T_s - T_n = (0.82)(102,000 + 208,000)(0.21 - 0.05) = 40.7$ Mg

Fugitive: $T_s - T_n = (0.82\ (102,000 + 208,000)(0.02 - 0.005) = \underline{3.8}$ Mg

91.6 Mg

Therefore, 96.1 Mg (100 tons) is the calculated reduction in nationwide particulate emissions from the perlite source category in 1985 if an NSPS is promulgated.

While not part of the Model IV methodology, the impact $(T_s - T_n)$ for a typical affected facility -- i.e., a dryer or furnace -- can be calculated by mutiplying the typical size of the affected facility by the difference in emission rates or

$$(T_s - T_n) = S\ (E_s - E_n) \qquad (4)$$

where S = typical size

The following results were obtained for a 27.2 Mg/hr (30 tons/hr) dryer and 0.9 Mg/hr (1 ton/hr) expanding furnace operated 4160 hours per year (16 hours/day, 5 days/week, 52 weeks/year).

- Dryer 15.9 Mg/yr (17.5 tons/yr)
- Expanding furnace 0.6 Mg/yr (0.7 tons/yr)
- Fugitive emissions 0.1 Mg/yr (0.1 tons/yr)

APPENDIX B

PERSONS WITH EXPERTISE IN THE PERLITE INDUSTRY IDENTIFIED DURING SOURCE CATEGORY SURVEY

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16. ABSTRACT

Background information is presented on the perlite industry for the purpose of determining the need for a new source performance standard (NSPS). The industry is surveyed and categorized by plant, process, and other factors. Information is presented on processes, emissions and air pollution control equipment. State and local regulations are summarized. The impact of a potential NSPS on particulate emissions is calculated.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
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