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Source Category Survey: Animal Feed Defluorination Industry

Emission Standards and Engineering Division

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1. SUMMARY

This report documents a study conducted to assess the need for new source performance standards (NSPS) for the animal feed defluorination industry. These standards would regulate airborne emissions from new point sources involved in the manufacture of defluorinated animal feed products.

This chapter is provided as a general overview of the study.

1.1 INDUSTRY DESCRIPTION

Defluorinated animal feed is a phosphate rock product that is added as a supplement to many animal feeds. It can constitute up to 10 percent of a given animal feed. Phosphate rock defluorination is accomplished by heating a mixture of phosphate rock, phosphoric acid, and caustic soda to temperatures up to 1370°C (2500°F). The fluorine content of the phosphate rock is thereby reduced from 3.5 percent to under 0.2 percent--a level safe for consumption by animals.

Presently, there are only three animal feed defluorination plants operating in the United States, and they are all located in Florida. The total combined production capacity of these three plants is 454.0 Gg/yr (500,000 ton/yr). Actual production over the past several years has been less than capacity. No significant growth is expected in the industry in the foreseeable future, but some expansion of the existing plants could occur.

1.2 PROCESS DESCRIPTION AND EMISSION SOURCES

Animal feed defluorination can be broken down into three main processes: feed preparation, thermal defluorination, and product storage and shipping. Feed preparation primarily involves the mixing and drying of raw materials. During thermal defluorination the prepared mixture is heated in order to volatilize the fluorine contained in the phosphate rock. The defluorinated product is then crushed to the proper size and either stored or shipped via rail or truck.

All sources of emissions directly involved with animal feed defluorination are considered in this study. Included are mixing, drying, thermal defluorination, and storage and shipping. Similar processes related to other parts of the phosphate rock industry (such as the phosphate fertilizer industry) are not considered since they are dealt with in a separate NSPS study.

Particulate matter is emitted to some degree from all of the processes mentioned above. Fluorides are emitted during the thermal defluorization process and, to a much lesser degree, during drying. The only emission data available are for well-controlled sources, and then only for mixing, drying, and thermal defluorination. Controlled particulate and fluoride emission rates for the combined mixing and drying processes are 0.11 kg/Mg P_2O_5 (0.22 lb/ton P_2O_5) and 0.0065 kg F/Mg P_2O_5 (0.013 lb F/ton P_2O_5), respectively. Average particulate and fluoride emission rates for thermal defluorination are 0.65 kg/Mg P_2O_5 (1.29 lb/ton P_2O_5) and 0.13 kg F/Mg (0.26 lb F/ton P_2O_5), respectively. Total national emissions from the quantifiable processes are 138 Mg/yr (142 ton/yr) of particulates, and 24.8 Mg/yr (27.3 ton/yr) of fluorides.

1.3 CONTROL SYSTEMS

Emissions of particulates and fluorides from all sources are controlled to a high degree. Baghouses or wet scrubbers control fugitive particulate emissions resulting from the handling of raw materials and product. Wet scrubbers are used to control particulate and fluoride emissions from the mixing and drying operations. The major source of emissions from animal feed defluorination plants, the thermal defluorination process, is controlled most commonly by a cyclonic entrainment separator followed by a spray crossflow packed scrubber. Particulates are removed and recycled by the cyclone, while fluorides and additional particulates are removed by the scrubber.

Best demonstrated emission control technology, with one minor exception, is essentially the same as described above: baghouses or scrubbers for raw material preparation and product handling, and cyclone/ wet scrubber systems for thermal defluorination. The different operating characteristics of the fluidized-bed thermal defluorination reactor (as opposed to the rotary kiln), however, may require one additional piece of control equipment. An ionizing wet scrubber (IWS) may be needed to control fine particulate emissions. Therefore, a cyclone/wet scrubber/IWS system constitutes best demonstrated control technology for a fluidized-bed reactor, while the IWS is not required when a rotary kiln is used.

The storage and shipping operations produce fugitive particulates during the loading of railcars and trucks. No emission data are available for this operation, but the best control system for this operation utilizes local exhaust hooding and ventilation ducted to baghouses. Visible observations of this operation indicate that this system effectively controls fugitive emissions.

1.4 STATE AND LOCAL EMISSION REGULATIONS

All three of the operating animal feed defluorination plants are located in Florida and are regulated by the Florida Department of Environmental Regulation (DER). The DER has promulgated regulations for both particulate and fluoride emissions from this industry. These regulations specify limits which require that the best demonstrated control technology be installed.

Allowable fluoride emissions are limited to 0.37 pounds of fluoride per ton of P_2O_5 input to the process. Based on a 3.5 percent fluoride content and a 35 percent P_2O_5 content for the feed material, this limit requires a control efficiency of 99.8 percent or greater.

Particulate emissions are regulated on the basis of a process weight table. No control efficiencies can be determined due to the lack of data on input particulates to the control devices. However, the most commonly used particulate control device, baghouses, typically achieve 99 percent or greater control.

1.5 SAMPLE COLLECTION AND ANALYSIS

There are EPA reference methods for the pollutants of concern from this industry, particulates and fluorides. EPA Method 5 is used for the determination of particulate matter. EPA Methods 13A and 13B are used for the determination of total fluorides.

1.6 RESULTS AND RECOMMENDATIONS

The results of this study indicate that there is no need for the development of NSPS for the animal feed defluorination industry. This recommendation is based on two important conclusions. First, all of the operating plants in this industry are located in the State of Florida and are well regulated. These plants have installed the best demonstrated technology to comply with state regulations. Second, there is limited potential for growth in this industry, and any growth or expansion which does occur will most likely occur at the present sites. Since these sites are effectively controlling the sources to comply with state regulations, any new sources at these sites would also be effectively controlled.

2. INTRODUCTION

The objective of this study is to determine the need for new source performance standards (NSPS) for the animal feed defluorination industry.

The Clean Air Act (CAA), as amended in 1977, provides authority for the U.S. Environmental Protection Agency (EPA) to control discharges of airborne pollutants. The CAA contains several regulatory and enforcement options for control of airborne emissions from stationary sources. Section 111 of the CAA calls for issuance of standards of performance for new, modified or reconstructed sources which may contribute significantly to air pollution. The standards must be based on the best demonstrated control technology. Economic, energy and non-air environmental impacts of best control systems must be considered in the development of standards.

To determine which processes and pollutants, if any, should be regulated by national NSPS, the following information has been provided in this survey:

- description of facilities included in source category,
- number and location of facilities,
- past and current volumes of production and sales, products and product uses,
- past and future growth trends in the industry,
- description of the processing operations and indentification of emission sources,
- characterization of emissions from source category,
- identification and description of control techniques currently used in the industry, including the degree of control achieved,
- identification of "best systems" of control,
- effectiveness of state regulations for new and modified facilities in the source category, and
- preferred methods of sampling and analyzing the pollutants.

Information in the above categories was gathered from several sources. First, a telephone survey of the industry trade association, National

Feed Ingredients Association, and other non-industry organizations was conducted to collect background information on the animal feed defluorination industry. A literature search was completed to obtain published information. Producers of defluorinated feed product, regional offices of EPA, and state air pollution control agencies were then contacted via phone or letter to obtain additional information. Two feed defluorination plants and three Florida air pollution control agencies were visited.

This study focuses on all emission sources of air pollutants which are not regulated by other NSPS or which are not associated with phosphate mining operations. Standards for this industry should not be confused with those for the phosphate fertilizer and phosphate rock processing industries. A discussion on emissions specific to the phosphate rock defluorination industry is given in Chapter 5.

3. CONCLUSIONS AND RECOMMENDATIONS

3.1 CONCLUSIONS

The following conclusions have been made based on the results of this study:

- Growth of Industry--the animal feed defluorination industry will continue to grow at its historic rate of 3 to 6 percent per year. This growth translates into possibly one more unit, either a rotary kiln or a fluidized-bed reactor, being installed in the next 3 to 5 years. This expansion will most likely occur at the present defluorination plant sites, all of which are located in Florida.

- Available Control Technology--control technology is presently available to control all operations in the animal feed defluorination industry to levels required by state regulations. The control technology used in this industry is considered best demonstrated technology.

- Identification of Significant Emission Sources--the only two significant emissions sources are the effluents from feed preparation and thermal defluorination. Emissions from feed preparation consist primarily of particulates while thermal defluorination emits both particulates and fluorides.

- Availability of Emission Data--relatively few emission measurements are available for this industry. Most of the available data are for the thermal defluorination operation. Very limited data are available for the feed preparation operation. The available data do not include inlet measurements, but include only outlet emission levels. Therefore, determination of control efficiency for most operations involves estimates of inlet amounts. The data do indicate compliance with state regulations.

- Applicable Methods for Sample and Analysis--EPA reference methods are available and applicable for both pollutants of concern. EPA Method 5 is used for particulate determination and EPA Methods 13A and 13B determine total fluoride emissions.

3.2 RECOMMENDATIONS

The recommendation of this source category survey report is that new source performance standards not be developed for the animal feed defluorination industry. This recommendation is based on two important conclusions reached during this study. The first of these conclusions is that all of the operating plants are in the state of Florida. The Florida Department of Environmental Regulations (DER) has promulgated regulations controlling the emissions of particulates and fluorides from the processes in this industry. These regulations specify emission limitations which require that the best demonstrated control technology be installed to control particulates and fluoride emissions from animal feed defluorination. Available emission data indicate that the control technology presently used can achieve these levels of emissions.

The second conclusion is that there is a small potential for growth in this industry and that any expansion would take place at the present locations. Therefore, any expansion would require installation of best demonstrated control technology to meet the Florida State regulations.

4. DESCRIPTION OF INDUSTRY

4.1 SOURCE CATEGORY

At present, the animal feed defluorination industry consists of just three functional plants. The Borden Chemical Company operates a facility at Plant City, Florida; International Minerals and Chemical Corporation operates one at Mulberry, Florida; and Occidental Chemical Company operates one at White Springs, Florida. Other phosphate rock defluorination plants have been in operation at one time or another in the past but have been shut down. Rocky Mountain Phosphate ran a small operation at Garrison, Montana, but was forced to close it down because of financial difficulties. According to one source with the State of Montana Air Pollution Control Agency, the plant was not well run and would require significant capital investment to make it operable again.[1] There appear to be no plans to reopen the facility. Similarly, Olin Chemical Company's 68.1 Gg/year (75,000 ton per year) defluorination plant in Pasadena, Texas was closed in January of 1978. The plant's location, requiring phosphate rock to be shipped in over considerable distances, caused it to be unprofitable.[2] Table 4-1 summarizes the animal feed defluorination industry.

A number of persons have been helpful in providing information regarding the animal feed defluorination industry. Included are persons involved in the industry at both the corporate and plant level, as well as those engaged in a regulatory capacity at the state level. Table 4-2 lists these people, their affiliations, and their addresses and phone numbers.

4.2 INDUSTRY PRODUCTION

Production figures for the animal feed defluorination industry proved to be difficult to ascertain. As of 1971, production capacity was 485.8 gigagrams per year (535,000 tons per year), according to the literature.[3] That figure would be accounted for (approximately) by the combined capacities of the Borden, Occidental, Olin, and Rocky Mountain

TABLE 4-1. SUMMARY OF ANIMAL FEED DEFLUORINATION PLANTS IN THE UNITED STATES

COMPANY	PLANT LOCATION	PRODUCTION CAPACITY Gr/yr (T/yr)	NUMBER OF EMPLOYEES	REMARKS
Borden	Plant City, Florida	272.4 (300,000)	NA	
IMC	Mulberry, Florida	90.8 (100,000)	NA	
Occidental	White Springs, Florida	90.8 (100,000)	10-15	
Olin	Pasadena, Texas	68.1 (75,000)	NA	Shut down in 1978
Rocky Mtn. Phosphate	Garrison, Montana	NA	NA	Shut down in 1976

NA-Not Available

TABLE 4-2. LIST OF PERSONS WITH EXPERTISE IN THE ANIMAL FEED DEFLUORINATION INDUSTRY

NAME	AFFILIATION	ADDRESS	TELEPHONE NUMBER
Tom Blue	Stanford Research Institute	Menlo Park, Calif.	415-326-6200
Lynn Christian	Borden Chemical	Norfolk, Virginia	804-461-7200
John Cole	Florida DER*	Jacksonville, Fla.	904-396-6959
Dee Dibble	IMC	Mundelein, Ill.	312-564-8600
Bruce Galloway	Borden Chemical	Plant City, Fla.	813-752-1161
Bob Garrett	Florida DER*	Tampa, Fla.	813-985-7402
Jerry Girardin	IMC	Mulberry, Fla.	813-428-2531
Jack Harris	IMC	Muldelein, Ill.	312-566-2600
Harry Keltz	Rocky Mountain Phosphates	Garrison, Montana	406-449-3454
Jack Lewis	Borden Chemical	Plant City, Fla.	813-752-1161
Gene McNeil	Occidental Chemical	White Springs, Fla.	904-397-8270
Walter Starnes	Florida DER*	Tallahassee, Fla.	
Marvin Vinsand	National Feed Ingredients Assoc.	Des Moines, Iowa	515-225-9611

*DER-Department of Environmental Regulation plants (the IMC plant did not start operating until 1978). Actual production figures for that year are unavailable.

For the years 1976 and 1977, the amounts of defluorinated animal feed "sold or used" in the U.S. were 235.2 and 270.6 gigagrams (259,000 and 298,000 tons), respectively.[4,5] It must be assumed that these figures would closely approximate actual production figures. Production capacity for those years would have been about 431.3 Gg/yr (475,000 tons per year) (from Borden, Occidental, and Olin).

Production capacity for the past year (1979) was 454.0 gigagrams (500,000 tons) which is less than the 1971 production capacity. The three operating plants in 1979 were Borden, Occidental, and IMC. Again, actual production figures were hard to determine. According to sources at the three plants, Occidental was producing at or near capacity.[6] IMC, in only its first full year of operation, had achieved a production rate of nearly 63.6 Gg/yr (70,000 tons per year)[7]. Borden produced an unknown amount of animal feed, which was reportedly less than capacity.[8] All of the above figures are estimates.

As to the future growth in the industry, several sources have placed the annual growth rate at between two and six percent.[9,10] However, it was also learned that the demand for defluorinated animal feed products is cyclic in nature and changes from year to year.[11] The major factor effecting this demand is the price of other feed supplements, such as fish meal, which can be substituted for defluorinated phosphate rock.[12]

Expansion plans are also somewhat indefinite. Borden plans to build a more thermally efficient rotary kiln at the present location to replace an older unit which would then be used to handle peak loads.[13] The date for this expansion was not available. IMC is currently conducting a market survey to determine growth and expansion potential.[14] Sources at Occidental indicated that expansion of the defluorination facilities within the next few years did not appear too likely.[15]

The likelihood of thermal defluorination facilities locating outside of Florida seems small. Due to economics, operations generally have to be mine mouth and the phosphate rock has to be high quality. Texasgulf operates a phosphate rock plant at Aurora, North Carolina, which has supplies of animal feed grade phosphate rock. However, this rock evidently has some different characteristics which preclude the use of current technology for defluorination. Therefore, Texasgulf presently has no plans to enter the defluorination industry. Should a technological breakthrough occur which would make processing of this particular rock technically feasible, Texasgulf indicated they would seriously investigate the possibilities of entering the industry.[16]

4.3 PROCESS DESCRIPTION

The animal feed defluorination process considered in this study consists of three operations: 1) feed preparation, 2) thermal defluorination, and 3) product storage and shipping. Figure 4-1 presents a general flow sheet for this process.

The primary raw materials for this process are phosphate rock, phosphoric acid, and caustic soda. These materials are combined in a mixer, typically a pug mill or a rotary drum mixer, to produce a homogenous mixture. This mixture is then dried to the proper moisture content as required for the thermal defluorination operations and is stored in hoppers. Emissions from the feed preparation operation include particulates from the mixing operation and possibly gaseous fluorides and particulates from the dryer. The moist nature of the feed materials minimizes the amount of particulates produced during the mixing operation. The dryer does not operate at high enough temperatures to release significant amounts of fluoride as compared to the defluorination operation.

Thermal defluorination of phosphate rock is accomplished by heating the feed mixture up to approximately 1370°C (2500°F). The fluorine is driven off primarily as hydrogen fluoride (HF). This operation is carried out in two types of equipment, rotary kilns and fluidized-bed reactors. In the rotary kiln operation, the feed mixture is introduced at one end of a long slightly inclined cylindrical kiln. The kiln rotates and is fired from the end opposite the feed, resulting in counter current flow. Product material, defluorinated rock, is discharged at the firing end, while the process gases exit at the feed end.

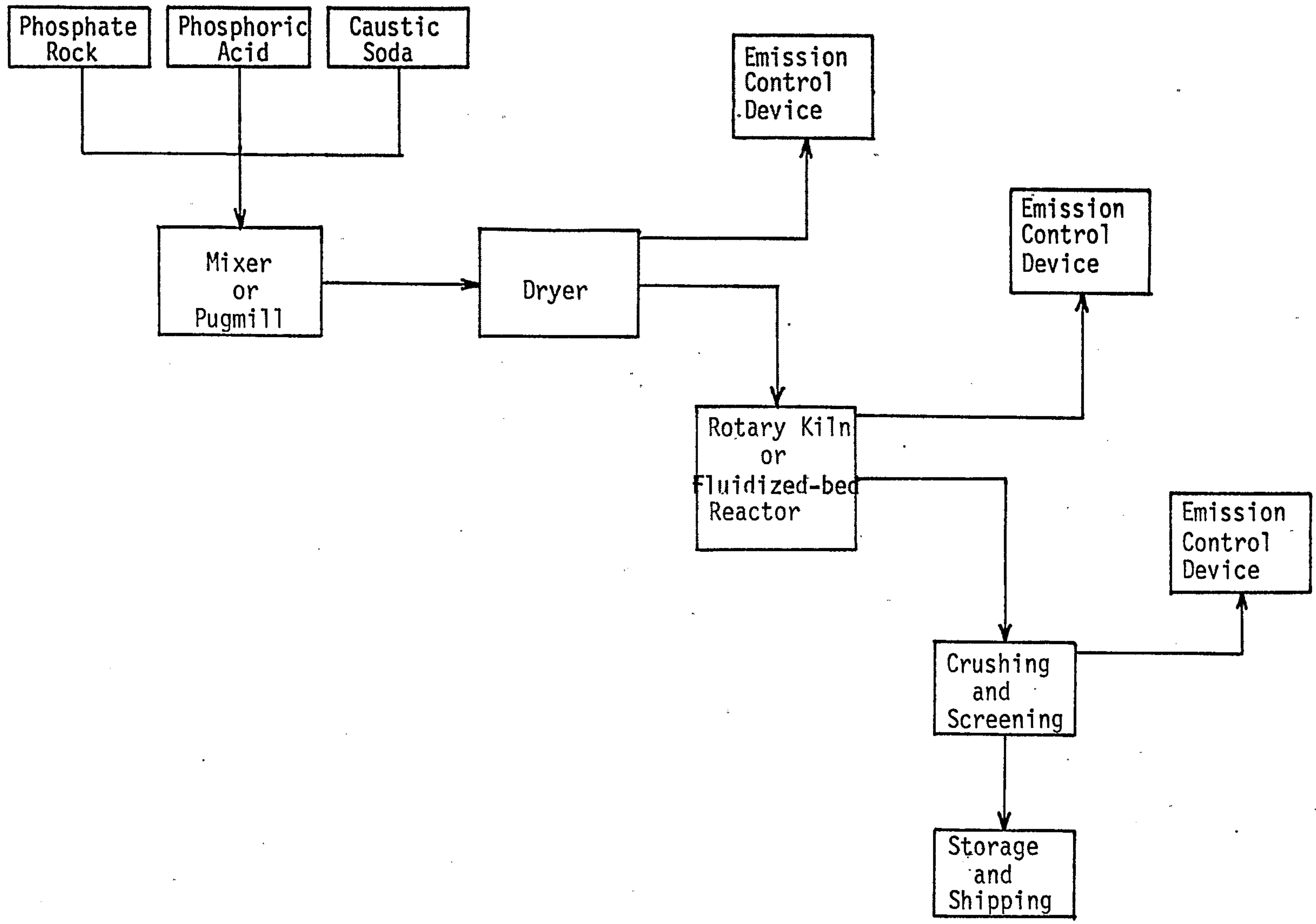

FIGURE 4-1. GENERALIZED ANIMAL FEED DEFLUORINATION INDUSTRY PROCESS FLOW DIAGRAM

The fluidized-bed reactor operation differs in that the reactor remains stationary while a stream of air and fuel fluidize the feed mixture or bed within the reactor. The process of fluidizing converts a bed of solid particles into an expanded, suspended mass that resembles a boiling liquid. Space must be provided for vertical expansion of the solids and for disengaging entrained material. The usual shape is a vertical cylinder. The product material overflows at the top of the bed and the process gases exit at the top of the reactor.

Both the rotary kiln and the fluidized-bed reactor are usually fired with natural gas, with LPG or fuel oil used during curtailment. There is very limited potential for use of coal in these processes due to the purity requirements of the feed supplements.[17]

The emissions produced by these operations are also very similar, consisting of particulates and gaseous fluorides. The particulates are composed primarily of product and are recovered for economic reasons as well as emission regulations. The fluoride emissions, primarily in the form of HF, are the major pollutant which must be controlled. The defluorinated rock product is cooled and sent to product shipping and storage. The product may be shipped in bags or loose in railcars or by trucks. Loading of rail cars and trucks with loose product produces fugitive particulate emissions consisting of product material.

The amounts of emissions produced by these processes and the types of control equipment used to control these emissions are discussed in Chapters 5 and 6, respectively.

4.4 REFERENCES

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4. Pit and Quarry, January 1978. p. 102.
5. Pit and Quarry, January 1979. p. 99.
6. Meling, J.L. Trip Report: Occidental Chemical Company, White Springs, Florida. Radian Corp. Durham, N.C. December 26, 1979.
7. Telecon. Meling, J.L. Radian Corp. with Jack Harris, International Minerals and Chemical Corp. January 15, 1980.
8. Hoover, J.R. Trip Report: Borden Chemical Company, Plant City, Florida. Radian Corp. Durham, N.C. January 4, 1980.
9. Reference 2.
10. Reference 8.
11. Reference 8.
12. Reference 8.
13. Reference 8.
14. International Minerals and Chemical Corp., Response to Section 114 request for information, January 14, 1980.
15. Reference 6.
16. Telecon. Meling, J.L. Radian Corp. with Frank Robinson, Texasgulf. January 21, 1980.
17. Reference 8.

5. AIR EMISSIONS DEVELOPED IN THE SOURCE CATEGORY

This chapter deals with the types and quantities of emissions resulting from the source category. Included are particulates and fluorides emitted during feed preparation, thermal defluorination, and product storage and shipping. Sources considered in this source category are different than those covered by proposed NSPS regulations for the phosphate rock industry, even though the source types are similar. Common emissions source types, such as drying, grinding, and screening, that are not directly associated with the defluorination process are not considered. Figure 5-1 illustrates the general flow scheme for the Florida phosphate rock industry. The defluorination of phosphate rock involves mixing the rock with phosphoric acid and caustic soda, a process unique to the rest of the phosphate rock industry. Only emission sources related to this and other defluorination operations are covered here, as is shown in Figure 4-1.

5.1 PLANT AND PROCESS EMISSIONS

This section is concerned with the development of emission factors for the pollutants and sources identified above. The term emission factor, as used in this report, refers to a number which quantifies the emission per unit of product passing through a process. Both emission and process units are usually given in mass units. Thus, emission factor units typically take the form of kg/Mg (lb/ton).

Emission factors were developed exclusively using the limited amount of industry stack test data. Since the stacks were tested while emission controls were engaged, no actual data for uncontrolled emissions are available. Also, EPA document AP-42 contained no information on emission factors for animal feed defluorination.

5.1.1 Feed Preparation Emissions

Feed preparation involves the mixing of raw materials, as well as the drying of the resulting mixture. Only particulates are emitted during the mixing of raw materials (phosphate rock, phosphoric acid, and

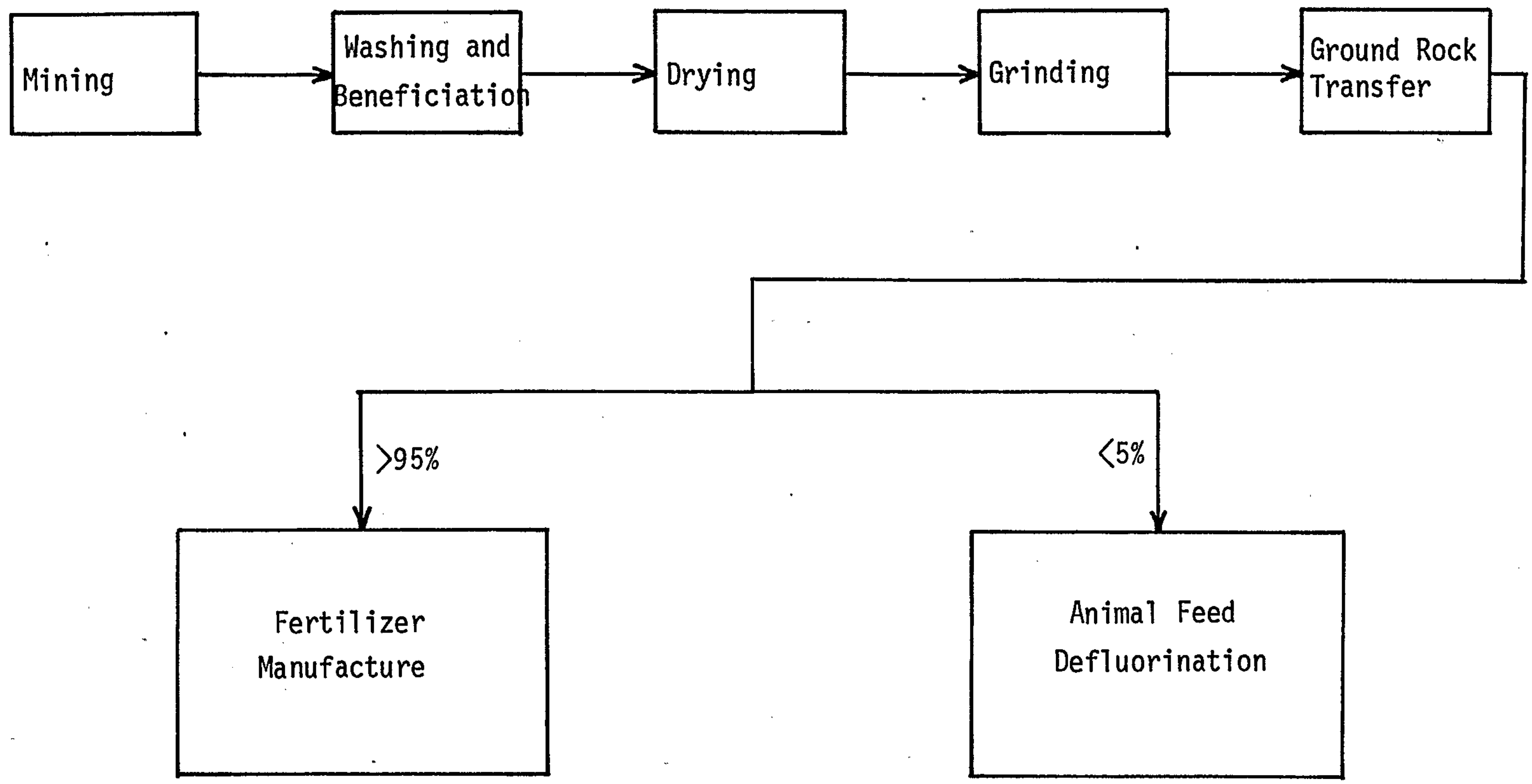

FIGURE 5-1. GENERALIZED FLOW SCHEME FOR FLORIDA PHOSPHATE ROCK OPERATIONS

caustic soda), while particulates and a small amount of fluorides are emitted during the drying process. No emissions data exist for uncontrolled emissions from the feed preparation area, but a test was performed on the stack from controlled mixing and drying processes. The measurement was taken after a wet scrubber and indicated particulate emissions of 0.11 kg/Mg P_2O_5 (0.22 lb/ton P_2O_5) and fluoride emissions of 0.0065 kg F/Mg P_2O_5 (0.013 lb F/ton P_2O_5).[1] No data exist to make a similar estimation for an uncontrolled plant.

5.1.2 Thermal Defluorination Emissions

Both particulates and fluorides are emitted during the thermal defluorination process (rotary kiln or fluidized-bed reactor). Available data for well-controlled plants (using both rotary kilns and fluidized-bed reactors) suggest particulate emission rates of 0.65 kg/Mg P_2O_5* (1.29 lb/ton P_2O_5). Fluoride emission rates average 0.13 kg F/Mg P_2O_5** (0.26 lb F/ton P_2O_5), as opposed to the Florida DER emission limitation of 0.185 kg F/Mg P_2O_5 (0.37 lb F/ton P_2O_5). The limited amount of data indicates no significant difference between the total weight of emissions from rotary kilns and fluidized-bed reactors.

No test data are available for fluorides from an uncontrolled facility. However, the fluoride emission rate can be estimated through a material balance. The defluorination process reduces the weight percent fluorine in the phosphate rock from 3.5 percent to 0.2 percent[2,3], resulting in uncontrolled emissions of 95 kg F/Mg P_2O_5 (190 lb F/ton P_2O_5). (This is in close agreement with an estimate of 105 kg F/Mg P_2O_5 (210 lb F/ton P_2O_5) found in the literature.[4])

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* Average value. Actual test data ranged from 0.26 to 1.09 kg/Mg P_2O_5 (0.53 to 2.18 lb/ton P_2O_5).[5,6,7]

**Average value. Actual test data ranged from 0.02 to 0.25 kg F/Mg P_2O_5 (0.04 to 0.49 lb F/ton P_2O_5) with only one value (0.49) over the 0.37 lb F/ton P_2O_5 limitation.[8,9,10]

5.1.3 Product Storage and Shipping Emissions

Product storage and shipping includes the crushing, screening, conveying, and loading out of defluorinated animal feed. Emissions from these sources are limited to fugitive particulates. No estimate of emission rates can be made.

5.2 TOTAL NATIONAL EMISSIONS FROM SOURCE CATEGORY

An estimate of total national emissions from the three operating feed defluorination plants can be made using production information presented in Chapter 4 and emission factor information presented above. The estimate is based on plant production capacities, which would be the worst case. Total national emissions of both particulates and fluorides can be calculated knowing that emissions (Mg/yr or ton/yr) are equal to the total national production rate (Mg product/yr or ton product/yr) multiplied by emission factors (kg/Mg product or lb/ton product)* and the proper conversion factors. Total national emissions are presented in Table 5-1.

*Emission factors are converted to kg/Mg (lb/ton) product knowing that defluorinated animal feed is approximately 40 percent P_2O_5.[11]

TABLE 5-1. ESTIMATE OF TOTAL NATIONAL EMISSIONS OF PARTICULATES AND FLUORIDES DEVELOPED IN THE ANIMAL FEED DEFLUORINATION INDUSTRY

Particulates*	Fluorides
138.0 Mg/yr (142.0 ton/yr)	24.8 Mg F/yr (27.3 ton F/yr)

*Not including potential fugitive emissions from crushing, screening, conveying, and product storage and shipping.

5.3 REFERENCES

1. Borden Chemical Company, Plant City, Florida. Stack Compliance Test Results. October 2, 1978 through October 26, 1979.

2. Hoover, J.R. Trip Report: Borden Chemical Company, Plant City, Florida. Radian Corp. Durham, N.C. January 4, 1980.

3. Resources Research, Inc. Engineering and Cost Effectiveness Study of Fluoride Emissions Control (Final Report). January, 1972. p. 3-179.

4. Reference 3. p. 183.

5. Reference 1.

6. International Minerals and Chemical Corporation, Mulberry, Florida. Emission Test Results. September, 1979.

7. Occidental Chemical Company, White Springs, Florida. Point Source Test Results. February 16, 1977 through August 10, 1978.

8. Reference 1.

9. Reference 5.

10. Reference 6.

11. Reference 3. p. 181.

6. EMISSION CONTROL SYSTEMS

The various types of air pollution control equipment in use in the animal feed defluorination industry to control airborne emissions are briefly reviewed in this section.

The major emissions of concern from animal feed defluorination are particulates and fluorides. The other pollutants resulting from drying and thermal defluorination are primarily combustion products. The use of clean burning fuels, such as natural gas, and use of good combustion practices result in negligible levels of carbon monoxide and sulfur oxides.

The various manufacturing operations used in this industry are discussed in Chapter 4. The important control systems presently in use are discussed in the following sections of this chapter.

6.1 CONTROL APPROACHES

The major source of emissions from animal feed defluorination plants is the gas stream from the thermal defluorination operation. This gas stream must be treated to eliminate particulates and gaseous fluoride prior to discharge into the atmosphere.

The most common method of control for this stream consists of a cyclonic entrainment separator followed by a wet scrubber system.[1,2,3] The cyclone achieves bulk removal of the particulates. The wet scrubber system is used to increase particulate removal and to control gaseous fluoride emissions. This wet scrubber system is usually a spray cross-flow packed scrubber, a design which incorporates the features of both spray towers and packed towers. The fluoride removed by the wet scrubbing system can be disposed of as a waste or recovered as a byproduct. The most common method of removal as a waste involves precipitation of the fluorine as calcium fluoride by the addition of lime to the scrubbing liquor.[4] This reaction occurs in settling ponds and the pond overflow is recycled to the scrubber.

The other method of fluoride disposal involves reaction of the fluoride with chemicals to produce a usable, saleable byproduct. One plant recovers at least 60 percent of the fluoride as byproducts, such as potassium fluoroborate.[5]

In addition to the wet scrubber system, one plant has installed ionizing wet scrubbers (IWS) to control fine particulates from their fluidized-bed reactors.[6] Each IWS system is a double stage unit. The IWS system consists of a high voltage ionizing section and a wet scrubbing section. As the gas passes through the IWS, submicron particulate matter as well as soluble and reactive gases are removed. This system is designed to remove solid and/or liquid particulates down to 0.05 micron size.[7]

Emissions from the feed preparation operation, primarily particulates with small amounts of gaseous fluorides from the drying operation, are controlled by fabric filters and/or wet scrubbers.[8] The equipment used for feed preparation, pug mills, rotary mills, and dryers of various designs, are equipped with conventional hooding and/or exhaust ventilation to capture emissions from those operations. These hoods are vented to control equipment for particulate and, to a much lesser extent, fluoride control. The most common control technique for particulates and fluorides from the mixing and drying operations is wet scrubbing.[9] One plant uses a baghouse to control particulates from the mixing and drying operations.[10]

Emissions from the product storage and shipping operations consist of particulates from the loading of trucks and rail cars with loose product. These fugitive emissions are controlled at one plant by a system of hooding and local exhaust ventilation ducted to baghouses.[11] Enclosure and ventilation of this operation is being investigated by another company. Fugitive dust problems exist at other transfer points but the plants were in the process of designing controls for these areas.

6.2 ALTERNATE CONTROL METHODS

The control systems now in use are capable of meeting the control requirements of each of the operations described in the previous section. Other methods of control may be introduced as conditions warrant, but there is no apparent need for developing any new control technology at the present time.

6.3 "BEST SYSTEMS" OF EMISSION REDUCTION

This section discusses the most effective systems of emission control for the two operations in the animal feed defluorination industry which are the most significant sources of emissions, feed preparation and thermal defluorination. Table 6-1 summarizes these controls and shows the location of the plant and the name of the plant contact.

The feed preparation operation includes mixing of raw materials and drying, if necessary to adjust moisture content. Two systems are in use to control emissions, essentially all particulates, from this operation: wet scrubbers and fabric filters.[12] Based on emissions testing data which are available, both of these systems can achieve about the same levels of particulate control. Both of these systems are capable of meeting the applicable state regulations.

Two types of processes are used to thermally defluorinate phosphate rock for use as an animal feed supplement. There are rotary kilns and fluidized-bed reactors.

The best control system for the rotary kiln process consists of a cyclonic entrainment separator for bulk particulate removal followed by a spray crossflow packed scrubber for fluoride removal and final particulate control. The overall efficiency of this system is 99.8 percent or greater for fluorides.[13] Actual control efficiency is difficult to determine for particulates but should be approximately the same as for fluorides.

The best control system for the fluidized-bed reactor process is the same system as for the rotary kiln with the possible addition of a fine particulate control device. The fluidized-bed reactor process may produce fine particulate matter which is not always efficiently controlled by the first system and may require fine particulate control. The best system for control of this fine particulate is an ionizing wet scrubber (IWS). The combination of this unit with the previous controls achieves an overall control efficiency for particulates and fluorides of 99.9 percent.[14]

TABLE 6-1. BEST SYSTEMS OF CONTROL

SOURCE	EMISSIONS	CONTROL	LOCATION	CONTACT
Feed Preparation	Particulates	Baghouse	Occidental Chemical Co. White Springs, Fla.	Gene McNeil 904-397-8270
	Particulates & Fluorides	Wet Scrubber	Borden Chemical Plant City Florida	Bruce Galloway 813-752-1161
Rotary Kiln Defluorination	Particulates, Fluorides	Packed crossflow Wet scrubber	Borden Chemical Co. Plant City Florida	Bruce Galloway 813-752-1161
Fluid Bed Reactor Defluorination	Particulates, Fluorides	Packed crossflow wet scrubber with ionizing wet scrubber	Borden Chemical Co. Plant City Florida	Bruce Galloway 813-752-1161
Storage and Shipping	Particulates	Local hooding, ventilation to baghouse	Borden Chemical Co. Plant City Florida	Bruce Galloway 813-752-1161

The product storage and shipping operation creates fugitive particulates, primarily during the loading of railcars and trucks with product. The best system for control of this operation utilizes enclosure and local exhaust ventilation ducted to baghouses during the loading operation. No estimate of the control efficiency could be made due to the lack of data. The limiting factor in this control scheme is the efficiency of the collection system, i.e. the hoods and enclosure.

6.4 REFERENCES

1. Hoover, J.R. Trip Report: Borden Chemical Company, Plant City, Florida. Radian Corp. Durham, N.C. January 4, 1980.
2. Meling, J.L. Trip Report: Occidental Chemical Company, White Springs, Florida. Radian Corp. Durham, N.C. December 26, 1979.
3. International Minerals and Chemical Corp., Response to Section 114 request for information, January 15, 1980.
4. Reference 2.
5. Reference 1.
6. Reference 1.
7. Ensor, D.S. Ceilcote Ionizing Wet Scrubber Evaluation. Meteorology Research Inc. Altadena, California. November, 1979.
8. References 1,2,3.
9. References 1,3.
10. Reference 2.
11. Reference 1.
12. References 1,2,3.
13. References 2,3.
14. Reference 1.

7. EMISSION DATA

7.1 AVAILABILITY OF DATA

Relatively few emission measurements are available for animal feed defluorination processes. There are three main sources of emission data: 1) National Emission Data System (NEDS), 2) test data on file with state or local agencies, and 3) information and test data obtained directly from the animal feed defluorination industries.

Emissions and emission rates by SIC numbers for specific plants and specific emission points can be obtained through the NEDS. Other useful information contained in NEDS reports include control equipment, collection efficiencies and fuel type. NEDS is not always up-to-date and the current test results are not always available. NEDS data are basically non-existant for the animal feed defluorination industry.

State or local agencies have information on most current test data and permit applications. Emission test data may also be obtained directly from the companies involved.

Available emission source test data for the animal feed defluorination industry has been summarized in Table 7-1. No data are available from uncontrolled facilities. The State of Florida only requires samples of gases emitted to the atmosphere. All three of the operating plants use similar methods for control of particulates and fluorides from the processes.

7.2 SAMPLE COLLECTION AND ANALYSIS

The two major air pollutant emissions from animal feed defluorination are particulates and total fluorides. There are EPA reference methods which are applicable for these pollutants:

Method 1: Sample and Velocity Traverses for Stationary Sources.

Method 2: Determination of Stack Gas Velocity and Volumetric Flowrate.

Method 3: Gas Analysis for CO_2, O_2, Excess Air and Dry Molecular Weight.

TABLE 7-1. EMISSION SOURCE TEST DATA[1,2,3]

Test Locations	Number of Tests	Test Method
Feed preparation stack	1	EPA Method 13B (Willard-Winter distillation)
Stack of 2 fluid bed reactors and 1 kiln	1	EPA Method 13B (Willard-Winter distillation)
Stack of 3 kilns	3	EPA Method 13B (Willard-Winter distillation)
Stack of 2 kilns	1	EPA Method 13B (Willard-Winter distillation)
Stack of 2 kilns and 1 dryer	4	EPA Method 13B (Willard-Winter distillation)
Stack of 2 fluid bed reactors	3	EPA Method 13B (Willard-Winter distillation)

Note: All of the above emission tests are measured after some type of control device. There are no test data on uncontrolled emissions.

Method 4:	Determination of Moisture Content in Stack Gases.
Method 5:	Determination of Particulate Emissions from Stationary Sources.
Method 13a:	Determination of Total Fluoride Emissions from Stationary Sources SPADNS Zirconium Lake Method.
Method 13b:	Determination of Total Fluoride Emissions from Stationary Sources Specific Ion Electrode Method.

Particulate size is of importance because small particles, less than 5 micrometers in size, are carried into the human lung. There is no standard EPA method for determining particle size. However, the Cascade impactor can be used for sizes between 0.4 and 10 micrometers and recent developments such as the Coulter Counter and Thermosystems aerosol size analyzer have been used for particles between 0.1 and 1 micrometer.

7.3 REFERENCES

1. Borden Chemical Company, Plant City, Florida. Stack Compliance Test Results. October 2, 1978 through October 26, 1979.
2. International Minerals and Chemical Corporation, Mulberry, Florida. Emission Test Results. September, 1979.
3. Occidental Chemical Company, White Springs, Florida. Point Source Test Results. February 16, 1977 through August 10, 1978.

8. STATE AND LOCAL EMISSION REGULATIONS

All three of the operating animal feed defluorination plants are located in Florida. The State of Florida Department of Environmental Regulation (DER) has promulgated regulations which require control of particulate and fluoride emissions from the thermal defluorination of phosphate rock for use as an animal feed supplement.

The emission limits specified by these regulations are the same for new facilities and existing facilities. The regulations limit fluoride emissions to 0.37 pounds of fluoride per ton of phosphate produced expressed as tons of P_2O_5.[1] Based on the characteristics of the fluoride rock processed in Florida, typically 3.5 percent fluoride and approximately 35 percent P_2O_5, these regulations require that the effluent gas streams be controlled by systems having control efficiencies of 99.8 percent or greater for fluorides.

Particulate emission limits are on the basis of a process weight regulation. For a process weight rate up to 30 tons per hour, the allowable emissions are expressed by $E = 3.59\ P^{0.62}$ where E equals the allowable emission rate in pounds per hour and P equals the process weight in tons per hour. For weight rates greater than 30 tons per hour, the expression is $E = 17.31\ P^{0.16}$. Florida also has a visible emissions regulation limiting stack densities to less than 20 percent opacity. However, this visibility regulation does not apply to emissions regulated by the process weight limitations. The regulations also require that reasonable precautions be taken to prevent fugitive particulate emissions from any source.[2]

Using the process weight limit equation for particulates and the allowable of 0.37 pounds per ton P_2O_5 fluoride limit, typical emission rates for the fluidized-bed reactor process and the rotary kiln process are as follows:

Process	Typical Process Rate (ton/hr)	Particulate Emissions (lb/hr)	Fluoride* Emissions (lb/hr)
Fluidized-Bed Reactor	8.0	13.0	1.04
Rotary Kiln	3.5	7.8	0.45

*based on feed raw material P_2O_5 content of 35 percent

The State of Florida has a very active enforcement branch. Plants are required to submit compliance stack tests twice a year, with state people present during the tests. The state has a fairly extensive file on each of the defluorination plants, with detailed construction and operating permits and all compliance testing data.

The DER plans to review the regulations for thermal defluorination this year to determine if changes in the particulate regulations should be made. They feel no need to change the fluoride emission regulations.[3]

Local emission limits, where they exist, are adopted from the state regulations. These agencies, usually on a county level, act as a representative of the State DER.

The Florida State regulations came about in response to complaints about damage to vegetation, especially citrus trees, and to animals from ingestion of fluorine-contaminated vegetation. Over the last 25 to 30 years, the regulations have required improvement of the control systems to achieve almost complete removal of fluorides. According to state sources, there have been very few complaints in recent history, and none in the last two to four years.

8.1 REFERENCES

1. Rules of the Florida Department of Environmental Regulation, Chapter 17-2, Air Pollution.
2. Reference 1.
3. Reference 1.

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J. R. Hoover and J. L. Meling

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Durham, NC 27707

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16. ABSTRACT

This study investigated the need for new source performance standards (NSPS) for processes that defluorinate phosphate rock to produce an animal feed supplement. This defluorination is accomplished by heating phosphate rock in a kiln or fluidized bed to about 1370°C to drive off fluoride as HF.

It is recommended that NSPS not be developed. The only three domestic plants, all in Florida, have a very small growth potential. Any expansion within the next five years would probably be a single kiln or fluid bed furnace added to existing facilities at one of these plants. The total combined fluoride emissions are only 27 tons/year for the three plants. The best demonstrated control technology (a fabric filter or a wet scrubber) is already used at each plant, and the Florida State regulations will continue to make this type of control a practical necessity.

17. KEY WORDS AND DOCUMENT ANALYSIS

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