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Research Triangle Park NC 27711

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Ammonium Sulfate Manufacture — Background Information for Promulgated Emission Standards

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Emission Standards and Engineering Division

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Air, Noise, and Radiation
Office of Air Quality Planning and Standards
Research Triangle Park, North Carolina 27711

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ENVIRONMENTAL PROTECTION AGENCY

Background Information
and Final
Environmental Impact Statement
for Ammonium Sulfate Manufacture

Prepared by:

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1. The promulgated standards of performance will limit emissions of particulate matter from new, modified, and reconstructed ammonium sulfate dryers. Section 111 of the Clean Air Act (42 U.S.C. 7411), as amended, directs the Administrator to establish standards of performance for any category of new stationary source of air pollution which ". . . causes or contributes significantly to air pollution which may reasonably be anticipated to endanger public health or welfare."

2. Copies of this document have been sent to the following Federal Departments: Labor, Health and Human Services, Defense, Transportation, Agriculture, Commerce, Interior, and Energy; the National Science Foundation; and Council on Environmental Quality; to members of the State and Territorial Air Pollution Program Administrators (STAPPA) and the Association of Local Air Pollution Control Officials (ALAPCO); to EPA Regional Administrators; and to other interested parties.

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1.0 SUMMARY

On February 4, 1980, the Environmental Protection Agency (EPA) proposed standards of performance for ammonium sulfate manufacture (45 FR 7758) under authority of Section 111 of the Clean Air Act, as amended. Public comments were requested on the proposal in the Federal Register publication. There were six commenters which included State air pollution control agencies and representatives of three ammonium sulfate manufacturing plants. The comments that were submitted, along with EPA's responses to these comments, are summarized in this document. The summary of comments and responses serves as the basis for the revisions made to the standard between proposal and promulgation.

1.1 SUMMARY OF CHANGES SINCE PROPOSAL

Only two minor changes have been made to the proposed regulation. The indirect method of determining ammonium sulfate production rate for caprolactam by-product plants using a material balance computation now consists of an equation based on the combined feed stream leading directly to the crystallizer. The proposed standard provided an equation based on the two separate feed streams prior to being combined.

The other change involves a clarification that if a plant uses weigh scales to directly measure production rate, the use of flow monitors for the ammonium sulfate feed streams is not required. The standards as proposed would have required flow monitors even if weigh scales were provided.

1.2 SUMMARY OF IMPACTS OF PROMUGATED ACTION

1.2.1 Alternatives to Promulgated Action

The regulatory alternatives are discussed in Chapter 6 of the Background Information Document (BID), Volume I, Ammonium Sulfate Manufacture-Background Information for Proposed Emission Standards.

The two options, identified through review of the industry, are based on emission control techniques representative of two distinct levels of control. Option I is equivalent to no additional regulatory action. Option II (the promulgated regulatory limit) is based on the best demonstrated control technology. These alternatives remain the same; no new alternatives were identified.

1.2.2 Environmental Impacts of Promulgated Action

The environmental impacts are discussed in Chapter 7 of the BID, Volume I. Impacts on air pollution, water pollution, solid waste, and noise are discussed. The impacts remain unchanged. Therefore, the analysis of environmental impacts in Volume I of the BID now becomes the final Environmental Impact Statement for the promulgated new source performance standards.

1.2.3 Energy and Economic Impacts of Promulgated Action

The energy impacts are discussed in the BID, Volume I, Chapter 7. There are no changes to the estimated impacts. The impacts, therefore, remain unchanged.

Chapter 8 of the BID, Volume I, discusses economic impacts. There are no changes to these estimated impacts.

2.0 SUMMARY OF PUBLIC COMMENTS

The list of commenters, their affiliations, and the EPA docket number assigned to each of their comments are shown in Table 2-1. Six letters commenting on the proposed standard and the BID, Volume I, for the proposed standard were received. The significant comments have been combined into the following four categories:

1. General
2. Emission Control Technology
3. Test Methods and Monitoring
4. Miscellaneous

The comments, issues, and their responses are discussed in the following sections of this chapter. A summary of the changes to the regulations is included in Section 1.1 of Chapter 1.

2.1 GENERAL

Impact on New Sources

One comment stated that since ammonium sulfate is being used less frequently as a fertilizer, impact on new sources should be minimal.

Ammonium sulfate is one of the older forms of nitrogen fertilizer and is still used in significant quantities. However, since 1950 AS's share of the total nitrogen fertilizer market has declined as other nitrogen fertilizers have grown more rapidly. Although AS's percentage of the total nitrogen market will likely continue to decrease, total production is expected to increase. This increase in tonnage would be a result of additional by-product material from the steady growth in caprolactam production.

The production of caprolactam by-product ammonium sulfate, which represents over half of current production, is expected to increase at annual rates of 5 to 7 percent through 1985. Increased capacity and dryer replacement in the caprolactam by-product sector of the industry

TABLE 2-1. LIST OF COMMENTERS ON THE PROPOSED STANDARDS OF PERFORMANCE FOR AMMONIUM SULFATE MANUFACTURE

Item Number in Docket A-79-31	Comments and Affiliation
IV-C-1	Mr. Steve Smallwood Department of Environmental Regulation State of Florida Twin Towers Office Building 2600 Blair Stone Road Tallahassee, Florida 32301
IV-C-2	Mr. B.M. Beal NIPRO, Incorporated Post Office Box 1433 Augusta, Georgia 30903
IV-C-3	Mr. F.L. Piguet Hopewell Chemical Plant Allied Chemical Post Office Box 761 Hopewell, Virginia 23860
IV-C-4	Mr. James F. McAvory State of Ohio Environmental Protection Agency Box 1049 361 East Broad Street Columbus, Ohio 43216
IV-C-5	Mr. Daniel J. Goodwin Illinois Environmental Protection Agency 2200 Churchill Road Springfield, Illinois 62706
IV-C-6	Mr. J.F. Cochrane, Director Environmental Engineering Department J.R. Simplot Company P. O. Box 912 Pocatello, Idaho 83201

is expected to result in six new ammonium sulfate dryers coming on-line by 1985. While no new plants are expected to be constructed in the synthetic and coke oven by-product sectors of the industry, it is estimated that the replacement of existing process dryers in these sectors will result in six additional affected facilities by 1985.

Emission Limits for Other Pollutants

It was recommended by one commenter that an emission limit be established for sulfur dioxide and ammonia through specification of a modified Method 5 test procedure.

Study of the ammonium sulfate industry has shown that ammonium sulfate particulate matter is the principal pollutant emitted to the atmosphere from ammonium sulfate plants. Sulfur dioxide and ammonia are not emitted from ammonium sulfate plants in amounts significant enough to warrant regulation. EPA Method 5 provides detailed procedures, equipment criteria, and other considerations necessary to obtain accurate and representative particulate emission data and is the appropriate test procedure to measure ammonium sulfate particulate emissions. EPA Method 5 was used to gather the data which is the basis for the promulgated standards and is therefore specified as the method to be used for compliance testing.

New Source Performance Standards for Other Processes

One commenter thought that new source performance standards (NSPS) should be applied to any new ammonium sulfate dryer regardless of the manufacturing process used. The commenter referred to one plant which recovers ammonium sulfate from a scrubber controlling the emissions from a sulfuric acid unit at a phosphate fertilizer plant.

The standards regulate new, modified, and reconstructed dryers at three types of ammonium sulfate manufacturing plants: synthetic, caprolactam by-product, and coke oven by-product. Over 90 percent of ammonium sulfate is generated from these types of plants. During development of the standard, EPA determined that the impact of regulation and potential for emission reduction with new source performance standards is significant only within these industry sectors. These types of plants are the major sources of ammonium sulfate emissions. Only two plants in the U.S. are known to produce ammonium sulfate as a

by-product of sulfuric acid manufacture using the Cominco-Swenson process; the trend in this industry is toward using the dual absorption process of manufacturing sulfuric acid which eliminates the output of ammonium sulfate. Since there does not appear to be any growth or replacement potential for plants using the Cominco-Swenson process (this segment is in fact contracting), there is no justification to include this process in the standard.

Ammonium sulfate is also a by-product of the manufacture of nickel from ore concentrates and the manufacture of methyl methacrylate at one existing facility. However, no new plants of either type are expected to be built. Furthermore, new technology for the manufacture of methyl methacrylate now being put in use at existing plants eliminates the production of ammonium sulfate altogether.[1]

2.2 EMISSION CONTROL TECHNOLOGY

Specification of Control Equipment

One commenter suggested that the proposed standard be "equipment specific" requiring the use of venturi scrubbers. However, Section 111(h) of the Clean Air Act establishes a presumption against design, equipment, work practice, and operational standards. Such standards cannot be promulgated if a standard of performance is feasible. (Feasibility is defined in Section 111(h)(2) of the Act.) Performance standards for control of ammonium sulfate particulate emissions have been determined as practical and feasible; therefore, design, equipment, work practice, or operational standards are not considered as regulatory options.

Use of Fabric Filters to Meet Proposed Standards

Two comments were received which questioned the feasibility of utilizing fabric filters for the collection of particulate emissions at ammonium sulfate plants. Both commenters noted the fact that frequent and serious operational problems can occur with the use of fabric filter systems at ammonium sulfate plants. One commenter, a synthetic ammonium sulfate producer, pointed out that his company's efforts to utilize a baghouse were totally unsuccessful. The plant discontinued use of the fabric filter system because excessive blinding*

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*The embedded material blinds or plugs the fabric pore to such an extent that fabric resistance becomes permanently excessively high.

of the fabric and caking of the collected dust in the baghouse, bins, and discharge chutes occurred which required frequent plant shutdown (an operating pattern considered entirely unacceptable at large scale, continuous process ammonium sulfate plants).

The condensation which causes the blinding and caking results from failure to maintain the temperature of the dryer exhaust and/or baghouse surfaces sufficiently above the dew point at all times. The commenter noted that the presence of even low level sulfuric acid (or hydrocarbon) vapor effectively results in a gaseous mixture that has a dew point considerably higher than would be predicted solely on the basis of the moisture content. (This dew point elevation can exceed 200°F.)

EPA feels that this is a reasonable comment. Volume I of the BID and the preamble to the proposed standards contain information and data regarding the use of fabric filters for ammonium sulfate particulate control. Emission data include test results from the one fabric filter system presently in use in the ammonium sulfate industry. This control system was tested by EPA because it represents a unique application of this control method in the ammonium sulfate industry. From consideration of the emission test results, EPA judged that fabric filtration had the potential to reduce ammonium sulfate particulate emissions to the level required by the standards.

The baghouse used for particulate control at the synthetic ammonium sulfate plant was, however, not considered representative of normal fabric filter system operation. The baghouse in use was originally designed for another application but was applied to the ammonium sulfate plant in an effort to cut cost, since it was already in place at the site. The plant operates only intermittently and reported frequent operational problems associated with the use of the fabric filter system. EPA assumed that normal operation of a baghouse for ammonium sulfate particulate collection should be feasible (i.e., at temperatures above the dew point of the exhaust gas), albeit fabric filtration had not been demonstrated for the operational conditions encountered at a typical plant in the ammonium sulfate industry.

Industry personnel have previously stated that the large quantity of collected material (as high as 220 lbs of particulate matter per ton of ammonium sulfate produced) would create material handling problems associated with recycling the ammonium sulfate particulate collected by a fabric filter.[2] This is especially relevant when caking of the collected dust causes buildup in the baghouse, bins, and discharge chutes. Wet scrubbing, on the other hand, is more suitable for application to ammonium sulfate dryers. In wet scrubbing, ammonium sulfate process streams are used as the scrubbing liquor; this allows the collected ammonium sulfate (in solution) to be easily recycled to the process.

Capital and operating cost as well as energy requirements are also significantly higher for baghouses than for medium energy wet scrubbers of the same construction material. For example, the investment cost of a medium size caprolactam by-product ammonium sulfate plant is approximately $800,000 for fabric filters, compared to $150,000 for venturi scrubbers.

For the purpose of calculating environmental, economic, and energy impacts, EPA assumed that because of the relative advantages of wet scrubbing all facilites coming on-line by 1985 would elect to install wet scrubbers to meet the standards. EPA maintained that fabric filtration also had the potential to meet the proposed standards although their use has not been demonstrated in the industry.

With the additional information gained from investigation of the comments submitted on operational experience with fabric filtration at ammonium sulfate plants, there is now adequate evidence to conclude that fabric filtration is not a viable control alternative applicable to particulate collection at ammonium sulfate plants. Normal operation of a baghouse no longer appears feasible. This conclusion, however, does not affect the numerical emission limits proposed for ammonium sulfate dryer new source performance standards. The level of control in the proposed regulation was based on the use of a medium energy wet scrubber and represents the most stringent control level that can be met by all segments of the industry. Therefore, no change has been made in the numerical emission limit.

Fabric Filter Efficiency

One commenter reported that the efficiency as calculated from EPA test results appears to be in error. The commenter also stated that the 99.9 percent control efficiency for fabric filters cannot be relied upon for normal operating conditions at ammonium sulfate plants and that, although a control efficiency of 99.9 percent may be achieved, it cannot be sustained on a continuous basis during normal operating conditions.

Page C-10, Appendix C, of the BID, Volume 1, contains the reported efficiency calculated from EPA emission tests. Footnote "a" on that page outlines the efficiency calculation. A review of the calculation shows that the reported value of 98.7 percent is correct. That portion of the comment dealing with the operation of fabric filters is referred to in the preceding comments dealing with overall fabric filter feasibility.

Volatile Organic Compound Emissions At Caprolactam By-Product Plants

Two commenters were concerned with the effect of using fabric filters on volatile organic compound (VOC) emissions at caprolactam by-product ammonium sulfate plants. Both contended that although the use of fabric filters would reduce particulate emissions, VOC emissions would increase because a fabric filter would capture very little, if any, of the VOC which would be captured by a wet collection method.

Caprolactam is introduced into the ammonium sulfate process from those streams which, in the caprolactum formation reactions, produce ammonium sulfate as a by-product. Caprolactam, $(CH_2)_5$ COHN, has a melting point of 60°C and a boiling point of 140°C. This means that the majority of caprolactam present in the ammonium sulfate dryer at the operating temperature involved (about 85°C) is in the liquid phase. The liquid caprolactam in the dryer adheres to the ammonium sulfate crystals and passes through the drying and classifying process. This residual caprolactam is a solid at ambient storage conditions. Any volatile caprolactam present in the ammonium sulfate dryer (and exit gas) results from the vapor pressure of caprolactam at the operating temperature of the dryer. EPA test data indicate that uncontrolled volatilized caprolactam emissions are relatively low level: at least

two orders of magnitute lower than uncontrolled ammonium sulfate particulate emissions (110 kg/Mg for particulate matter versus 0.78 kg/Mg for caprolactam emissions). In addition, wet collection currently in use as particulate control has demonstrated nearly 90 percent removal of efficiency of the uncontrolled caprolactam emissions.

Furthermore, as pointed out in the previous comment concerning fabric filters, there is now adequate evidence to conclude that fabric filtration will not be selected to control particulate emissions from ammonium sulfate plants. For this reason it is concluded that VOC emissions will not increase as a result of baghouse use.

Control Equipment Efficiency and Process Variations

One commenter stated it is doubtful that either the venturi scrubber or fabric filter will be able to sustain 99.9 percent efficiency during all variations associated with normal operating conditions at ammonium sulfate plants. The commenter went on to say that EPA has repeatedly failed to consider variations associated with processes, control devices, testing equipment, and laboratory procedures and that EPA has failed to recognize the wide variations obtained from the same plant and pollution control system, as measured by EPA methods, during representative operating conditions.

The new source performance standards for this industry are not based on percent removal efficiency but on the performance level of the best system of continuous emission reduction considering cost and other factors. The percent efficiencies were provided for information purposes only. EPA determined the performance level through direct emission testing at a number of ammonium sulfate plants. To adequately consider all commonly occurring process and emission control variations found in the industry, EPA selected several plants for emission testing. The plants tested used the various drying techniques and gas-to-product ratios currently found in the industry and likely to be used in the future. For instance, both fluidized bed and rotary drum dryers were tested utilizing both direct-fired and steam heated air as the drying medium. Each emission test consisted of three separate test runs conducted during normal or representative operating conditions utilizing EPA Method 5. In the future, performance tests for determination of

source compliance will be conducted using procedures similar to those used in development of the promulgated standards. Emission test results from these different drying techniques indicate that the performance levels selected for the standards can be met by all segments of the ammonium sulfate industry.

2.3 TEST METHODS AND MONITORING

Use of Weigh Scales and Flow Monitors

One commenter suggested that §60.423(a) of the proposed standards, Monitoring of Operations, be changed to provide consistency with §60.424(d) which states that production rate may be determined by use of product weigh scales, or by material balance calculations. As proposed, §60.423(a) of the regulation would have required installation of process feed stream flow meters, even if weigh scales were used to measure production rate.

This is a reasonable comment. The emission limit of the regulation is expressed in allowable emissions per unit mass of product. Therefore, production rate must be determinable. Flow meters were required in an effort to provide a means to accurately determine the production rate at those facilities electing not to install weigh scales. It is not EPA's intention that owners or operators of affected facilities who elect to install weigh scales should also be required to install process stream flow monitors. The regulation has therefore been changed to note that if a plant uses weigh scales, then flow monitors are not required.

Pressure Drop Monitoring

One commenter requested that instead of continuous monitoring of pressure drop, periodic monitoring of pressure drop across the control system for any affected facility be allowed. It was suggested that the pressure drop across the control system should be taken by operating personnel at a frequency no greater than once every 2 hours and entered in an operator log. It was contended that the reliability of venturi scrubbers is such that more frequent measurements or continuous pressure drop monitors could not be justified and would be a waste of both capital and energy. It was stated that imposing more costly or

time-consuming monitoring requirements than is necessary to adequately demonstrate emission compliance will, in the long run, be counterproductive.

In EPA's experience, continuous pressure drop monitoring provides a more accurate indication of emission control equipment operation and maintenance than periodic or intermittant readings and thereby facilitates enforcement activities.[3] It has also been determined that the costs of continuous pressure drop monitoring at ammonium sulfate plants are reasonable, and that there are no technical or process reasons to monitor periodically. Therefore, no change in the pressure drop monitoring requirements of the proposed regulation was made.

Flow Monitoring Requirements

One commenter noted that for caprolactam by-product plants the ammonium sulfate feed streams which require flow monitoring devices for determination of mass product flow are, in some cases, inappropriate. It was pointed out that not all ammonium sulfate solution produced is taken to the solid form; some is sold as solution. Therefore, the total combined feed streams to the ammonium sulfate crystallizer, prior to any recycle streams, would be the most accurate place to measure process input feed.

This is considered a reasonable comment. For those caprolactam by-product ammonium sulfate plants not equipped with product weight scales, the proposed standards would have required that the oximation ammonium sulfate stream to the ammonium sulfate plant and the oleum stream to the caprolactam rearrangement reactor must be monitored separately as a means of determining the ammonium sulfate production rate. It did not specify that the total combined feed stream leading directly to the crystallizer stage can also be monitored. Therefore, in response to this comment, §60.424(d) has been changed to specify monitoring of the total or combined feed streams leading directly to the crystallizer stage for caprolactam by-product plants. A new equation has been developed for §60.424(d) to allow calculation of ammonium sulfate production rate from the flow rate of the total feed stream.

Flow Monitoring Accuracy

One commenter recommended that flow monitoring equipment be specified as ±10 percent and not ±5 percent as specified in the proposed standard. However, an accuracy of ±5 is considered to be practicably achievable. Equipment with this accuracy is available. Therefore, no change was made.

Opacity Standard

Another commenter contended that visual opacity measurement is unscientific, inaccurate, and, at best, arbitrary. It was suggested that the proposed opacity standard is unnecessary to adequately monitor ammonium sulfate manufacturing emissions; and since there is no reliable method for its measurement, the opacity standard should be deleted.

An opacity standard of 15 percent was proposed for all affected facilities to ensure proper operation and maintenance of control systems on a day-to-day basis. The proposed method for opacity monitoring is EPA Method 9. The reliability of opacity standards and the reference test method has been rigorously tested in the field and in the courts.[4,5] In the case of Portland Cement Association versus Russel E. Train, EPA Administrator, 513 F.2d 506 (D.C. Cir. 1975), the court ruled that plume opacity was not too unreliable to be used either as a measure of pollution or as an aid in controlling emissions. As a basis for the standard, ammonium sulfate dryers were observed to have no opacity readings greater than 15 percent opacity during observation periods totalling more than 19 hours. Therefore, no change was made in the opacity standard.

2.4 OTHER CONSIDERATIONS

Medical Evidence

One commenter could not find justification for proposing a standard for modified and new sources that is more stringent than the baseline emission level of existing SIP. It was contended that since there was no medical evidence presented showing any harm being created by ammonium sulfate dryer emissions allowed under existing State regulations, there is no justification for standards requiring additional investment and energy.

On August 21, 1979, ammonium sulfate manufacturing was listed under Section 111(f) of the Clean Air Act as a stationary source category for which standards should be promulgated (44 FR 4922). This listing represents the Administrator's determination that based on a preliminary assessment of the industry ammonium sulfate manufacturing causes, or contributes significantly to, air pollution which may reasonably be anticipated to endanger public health or welfare.

Under Section 111(a), any standards which are promulgated for source category must reflect the degree of emission control achievable through application of the best demonstrated technological system of continuous emission reduction which (taking into consideration the cost of achieving such emission reduction, any non-air quality health, and environmental and energy impacts) has been adequately demonstrated. Based on a thorough study of control alternatives, including no additional regulatory action, EPA has determined that the promulgated emission limits best satisfy these criteria for ammonium sulfate manufacture.

Furthermore particulate matter, the principal pollutant emitted to the atmosphere from ammonium sulfate plants, is a criteria pollutant (listed as such under Section 108 of the Clean Air Act) for which national ambient air quality standards have been established. Specific information regarding the health and welfare effects of particulate matter in the atmosphere was provided in association with the listing of particulate matter as a criteria pollutant.[6]

2.5 REFERENCES

1. Comment on Ammonium Sulfate BID by Mr. Thomas A. Blue, Manager of SRI's Agricultural Chemicals Business Studies Group. Contained in Mrs. B.J. Johnson's May 7, 1979, letter to S.T. Cuffe, EPA/ISB.

2. Telephone conversation between R. Zerbonia, PES, Incorporated, and R. Ray, Badische Corporation. April 19, 1979.

3. Telephone conversation between R. Zerbonia, PES, Incorporated, and R. Myers, EPA/DSSE, Washington, D.C., April 9, 1980.

4. EPA Response to Remand Ordered by U.S. Court of Appeals for the District of Columbia in Portland Cement Association vs. Ruckelhaus. EPA-450/2-74-023. November 1974.

5. Guidelines for Evaluation of Visible Emissions. EPA-340/1-75-007. April 1975.

6. Air Quality Criteria for Particulate Matter. National Air Pollution Control Administration. Publication No. AP-49. January 1969.

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15. SUPPLEMENTARY NOTES Volume I discussed the proposed standards and the resulting environmental and economic effects. Volume II contains a summary of public comments, EPA responses and a discussion of difference between the proposed and promulgated standards.

16. ABSTRACT

Standards of performance for the control of emissions from ammonium sulfate manufacture plants in the U.S. are being promulgated under Section 111 of the Clean Air Act. The standards apply to new, modified, or reconstructed facilities at caprolactam by-product, synthetic and coke oven by-product ammonium sulfate manufacturing plants.

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